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WIND - BIGHORN - CLARKS FORK RIVER BASIN

TYPE IV SURVEY

MAIN REPORT

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SOIL CONSERVATION SERVICE
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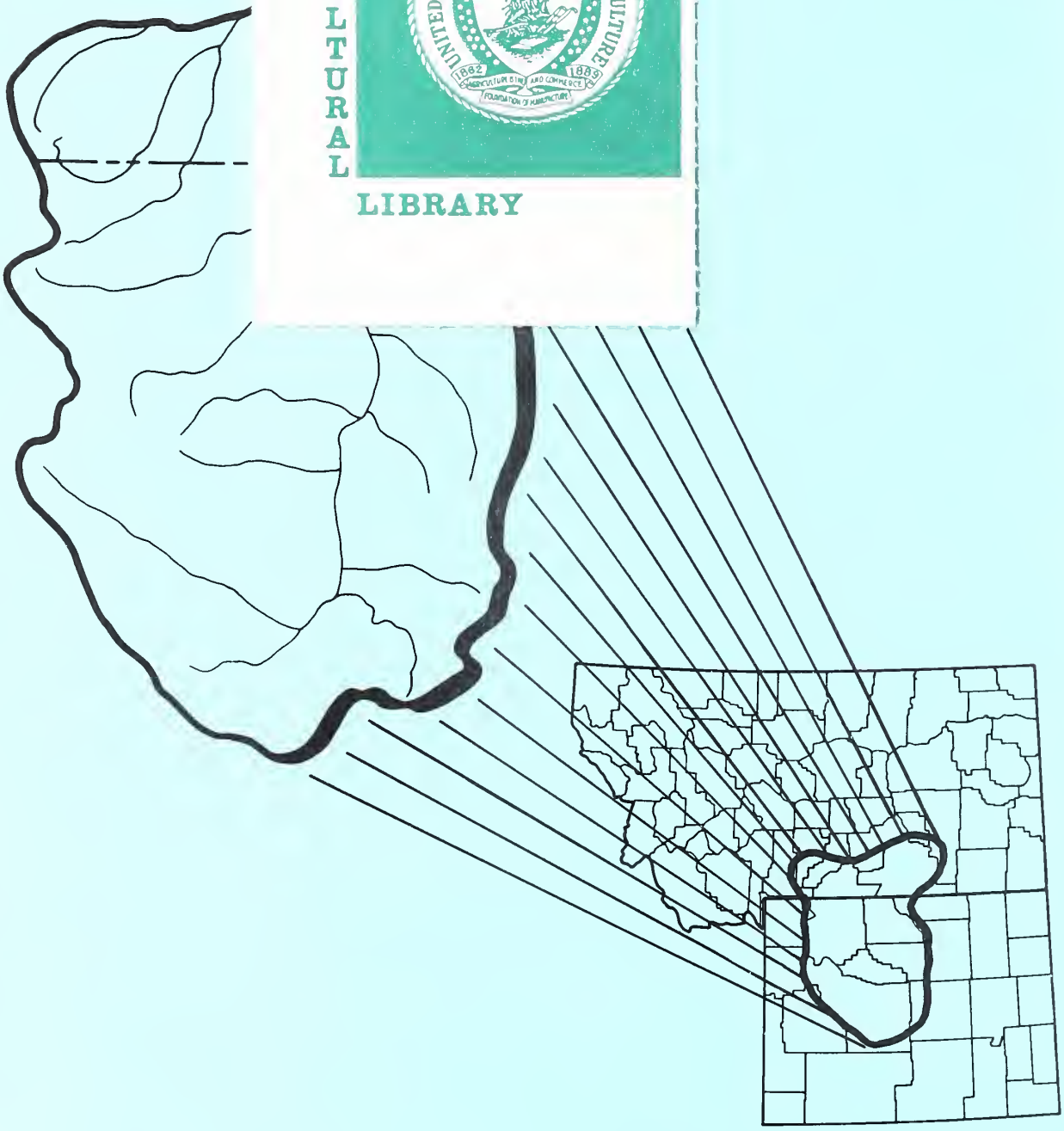
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DECEMBER 1974 USDA-SCS-PORTLAND, OREG. 1975

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MAIN REPORT

for the

WIND-BIGHORN-CLARKS FORK RIVER BASIN

Type IV Survey

USDA WATER AND RELATED LAND RESOURCES REPORT

Prepared by

UNITED STATES DEPARTMENT OF AGRICULTURE

ECONOMIC RESEARCH SERVICE - FOREST SERVICE - SOIL CONSERVATION SERVICE

in cooperation with

WYOMING STATE ENGINEER

and

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

December 1974

Under direction of

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ADDENDUM

WIND-BIGHORN-CLARKS FORK RIVER BASIN

TYPE IV STUDY REPORTS

In accordance with Advisory RB-3 of February 4, 1974, and WTSC Advisory RB-PO-2 which refers to the Water Resource Development Act of 1973, the following statement is submitted:

> Potential projects described in this report have been evaluated at 5 5/8 percent discount rate.

The Wyoming Supplement Interim Report for this study was submitted to the Washington Advisory Committee in March 1973 and constituted a "draft report transmitted to WAC for review."

WIND-BIGHORN-CLARKS FORK RIVER BASIN
TYPE IV SURVEY
MAIN REPORT

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U.S. DEPARTMENT OF AGRICULTURE
WIND-BIGHORN-CLARKS FORK RIVER BASIN
WYOMING AND MONTANA

SUMMARY

GENERAL

A few miles south of Thermopolis, Wyoming, is a place on the river known as "Wedding of the Waters." At this place the Wind River changes its name and becomes the Bighorn River. The Bighorn, Clarks Fork, and Stillwater Rivers are southern or right-bank tributaries of the Yellowstone River. Together with a few other tributaries between them, they drain about 28,390 square miles in Wyoming and Montana. About 72 percent of this area is in Wyoming and 28 percent is in Montana.

This is a report of a survey of the water and related land resources of the basin. The objective of this study is to promote a coordinated, orderly program for the conservation, management, use, and development of these resources.

This is the main report of the survey and is a general report which relates to the entire river basin. More specific information for each state is contained in the "Wyoming Supplement" and the "Montana Supplement" which are separate reports.

PROBLEMS AND NEEDS

The major human problem in the basin is underemployment. This problem is more serious among residents of the Indian reservations but is not limited to them. Underemployment rates in the area are about 15 percent of the male labor force and 40 percent of the female labor force, for a combined 21 percent of the total labor force.

A related problem is that per capita income for the basin's residents is about 19 percent below the national average. An improved economy is needed to provide more complete employment and better income distribution for the people of the basin.

Employment opportunities are limited in this basin and out-migration is about 70 percent of the population reproduction rate. From 1940 through 1970, about 27,000 people moved out of the basin. This is greater than the combined population of the four largest towns in the basin.

The major water and land resource problem is inadequate land treatment and management. On nonfederal range and dry pasturelands, only 34 percent is adequately treated and managed. Only 15 percent of the irrigated cropland and 40 percent of the nonirrigated cropland is adequately treated and managed.

Related to the problem of inadequate land treatment is the problem of erosion. High rates of runoff flowing through unstable gullies and streams cause about 80 percent of the basin's erosion damage. Erosion results in loss of productive soil, reduced crop production, damaged fish and wildlife habitat, damaged recreation sites, decreased farming efficiencies, damaged structures, reduced land values, damaged utility lines, and impaired aesthetic values. The major causes of erosion are (1) sparse vegetation cover, (2) improperly located roads and trails, (3) inadequate logging roads and skid trails, (4) off-road vehicular travel, (5) overgrazing, (6) wildfires, (7) mining, and (8) high rates of runoff from spring thaws and summer thunderstorms.

Erosion generally results in sediment damages downstream. There is some sediment damage to croplands when floods occur, but other sediment damages are more important in the average year. Sediment settles in irrigation canals and about 20 percent of the total length of these canals must have the sediment removed each year. Sediment loads in streams reduce water quality for agricultural, municipal, domestic, and industrial uses. Sediment in streams injures or kills fish and other aquatic life and reduces their reproduction rates. Sediment trapped in reservoirs reduces water storage capacities. The total capacity of the three large reservoirs in the basin is reduced about 6,400 acre-feet each year by sediment.

Floods are a problem in that they cause an average of over $145,000 worth of crop and property damage yearly. About 75 percent of this damage is to agricultural areas on tributary streams.

There are about 145,900 acres of land in the basin with excess water problems. Many of these are agricultural lands and need improved drainage and irrigation water management to be fully productive for agriculture.

The most important water supply problem is a shortage of late season irrigation water on presently irrigated lands. While most of the irrigated lands supplied with water from the main rivers of the basin are not seriously short of water, most of the lands supplied from tributary streams do not have enough water for full production.

Another problem is that livestock water supply points are not well distributed for proper range management. There are some water pollution problems associated with mine acid discharge and briny water from oil fields.

Forest problems include stands of low quality timber, inaccessible timber, slow timber growth due to overcrowding, inadequately skilled woods workers, and a lack of processing plants for small timber. Full use of forest recreation resources is inhibited by inadequate access across private lands, uneven distribution of developed facilities, an inadequate road network, insufficient trails development, and uneven distribution of lakes and other water developments. Control of trespass over private lands results in overcrowding of some existing access points to the public lands. Development of summer homes on private forest lands in a poorly planned, uncoordinated

manner, with inadequate sewer systems and roads, threatens water, land, and forest quality. Insect and disease damages are high, and as much as 50 percent of the gross annual timber growth may be lost to insects and diseases. Inefficient harvest methods cause additional losses of wood.

In 1980 the demand for the basin's timber will exceed the supply by 3,000,000 cubic feet. The demand is expected to exceed the supply by an increasing margin through 2020. An accelerated action program is needed if the timber supply is to be increased.

The recreation use of the basin is expected to increase from about 6,512,200 to 13,489,100 visitor-days by 2020. This is an increase of 107 percent. During peak use periods, the supply of some recreation facilities, particularly for camping, is less than adequate. The present need is greater in the Montana portion of the basin. By 2020 the need for new camping facilities will be nearly as great in Wyoming as in Montana. Private lands near public lands offer the best opportunity for the development of recreational facilities.

Winter habitat is the main limiting factor for most big game populations. The quality and quantity of winter habitat areas in the basin are decreasing because of man's activities. Moose winter habitat is most critical and should not be further altered without careful study and action to prevent serious reduction of the habitat.

FINDINGS AND CONCLUSIONS

The 1970 population of the basin was about 90,176 people. The population is projected to increase 54 percent to 138,700 people by 2020. The increase may be even higher if coal mines are developed in the basin. However, the rural farm population is expected to decrease from 17,070 to 11,300 people during the same period.

Agricultural production is projected to increase. Irrigated cropland is projected to increase from 770,250 to 857,000 acres by 2020. Production per acre will increase as well. The gross value of agricultural production is expected to increase from about $75,179,000 to about $160,978,000 in the same period. Beef production is expected to increase from 193,110,000 to 463,711,000 pounds live weight per year. The value of feed needed for all livestock produced in the basin will increase from about $50,322,000 to about $88,205,000. Some of this increase will occur without accelerated USDA programs.

There is potential to increase agricultural production, enlarge the timber industry, provide more recreation facilities, increase full employment, solve many of the problems, meet most of the needs of the basin, and maintain a high quality environment through the application of accelerated USDA programs. The following paragraphs outline some of the opportunities for USDA programs which have been identified in this study.

About 85 percent of the irrigated land in the basin can support a 50 percent increase in production through improved water supplies, management, and land treatment. About 1,360,750 acres of land not presently irrigated are suitable for irrigation if water is made available. While conflicts in land use will occur, there is enough land for both agricultural and nonagricultural purposes if development is properly planned.

Even in the most water short areas, there is water in high spring flows and short summer floods which can be stored if feasible reservoir sites exist. However, most possible reservoir sites have problems of limited capacity, poor location, poor foundations, and high construction costs. Good locations for ten reservoirs have been identified in the survey.

Where irrigated lands already have a good seasonal water supply, water quality and crop production can be improved through more efficient control of irrigation water. Where this reduces tailwater runoff and water-logging of lower elevation lands, there will be a reduction in the use of water.

The potential for large scale ground-water development from valley alluvium is limited because of thin aquifers and the likelihood of depleting flows in nearby surface streams. However, ground water can be developed in many locations in the basin. Some aquifers can supply large artesian flows of good quality.

Range and forest lands can be managed to provide more grazing, timber, recreation, and improved wildlife habitat. The supply of timber could be increased 50 percent with a program for insect and disease control. More complete harvest and processing efficiency could provide a 70 percent increase in usable wood. Better forest management could also provide a 50 percent increase in wood supply.

Watershed investigation reports have been written and distributed for 21 potential small watershed projects in the basin. An accelerated land treatment program is also proposed for each state's portion of the basin. Development of these projects and programs through USDA action and assistance can help solve the problems and provide for the needs of the basin. By the year 2000 the proposed watersheds could increase the value of the agricultural production by $7,404,000. About 54 percent of this increase would result from improving the seasonal supply of water to presently irrigated land. The increased agricultural production from the installation of these projects could support as many as 910 permanent new jobs. The new income to the basin could be $5,800,000 per year.

When projects are developed, care should be taken that wildlife habitat areas near the project site are not seriously degraded or that alternate measures are provided for protecting wildlife values. Interagency cooperation leads to better use of fish and wildlife resources and provides for increased benefits.

The present and future needs of the people of the basin can best be met through the development and improved conservation of the basin's resources. Much can be done with the help of existing or accelerated USDA programs. Where opportunities or needs are beyond the scope of USDA programs, they can usually be helped along if USDA programs are included in interagency efforts. There is particular opportunity for cooperative state-federal projects and programs.

RECOMMENDATIONS

The following specific recommendations outline USDA opportunities to manage, conserve, or develop the use of water and related land resources in the basin.

1. The land treatment program for nonfederal land should be accelerated to about double the application rate of presently existing programs. This would increase the estimated total installation costs from $56,948,000 to $101,400,000 over the next 25 years. An acceleration of federal technical and financial assistance will be required and could be administered through small watershed projects, the existing resource conservation and development projects, and cooperative forest programs.

2. Development and nondevelopment alternatives for national forest land management are described in this report. The expected tradeoffs between these alternatives, especially between 80,500,000 board feet of sawtimber and wood products and 850,000 acres preserved for Primitive Area activities,will require more detailed studies to evaluate.

3. Twenty-one potential small watershed projects are described in the reports prepared for this study. All of these projects are recommended for construction as soon as local sponsors show an interest in their development. It is further recommended that any project involving the storage of water for agriculture should be developed as soon as possible so as to establish water rights for this use.

Although all of the 21 potential small watershed projects could be considered for early action, eight are recommended as high priority projects. Three of these proposed developments are in Wyoming and five are located in Montana. The total installation cost for these eight projects is estimated to be $18,505,000. The remaining 13 proposed watershed projects have an estimated installation cost of $13,797,000.

The proposed high priority projects are listed below:

Project	Principal Feature
Wyoming	
Lower Greybull	Drainage
Nowood River Watersheds	Supplemental irrigation water
Gooseberry Creek	Supplemental irrigation water
Montana	
Blue Creek	Flood prevention
Pryor Creek	Irrigation
Two Leggins	Agricultural water management
Upper Little Bighorn River	Irrigation
Lodge Grass Creek	Flood prevention

4. Project measure proposals in the Beartooth and Bighorn Basin Resource Conservation and Development Projects should be studied in detail to determine engineering and economic feasibility of potential developments. Feasible projects should be installed as soon as local sponsors are ready to proceed.

5. Several reaches of streams are listed in the report which could be studied for inclusion in the National Wild and Scenic River System. Stream classifications other than those used in this system might also be considered.

6. The Indian water rights issue needs to be resolved as soon as possible. USDA agencies could assist by providing information concerning agricultural water requirements if requested.

7. The quantification and definition of federal reserved water rights should be concluded as early as possible.

8. Research is needed to probe into the real physical and environmental effects of changing water use patterns in the basin.

I. INTRODUCTION

This is a report of a study of problems, needs, potentials, and opportunities for the development and use of water and related land resources in the Wind-Bighorn-Clarks Fork River Basin. Opportunities are identified for programs and projects which can be administered or assisted by agencies of the U. S. Department of Agriculture. This study is needed to provide information for coordinated, systematic, multi-purpose development of these resources. The objective of this study and report is to outline a coordinated, orderly program for the conservation, management, use, and development of these resources.

Information available in this report will be helpful in the development of Montana and Wyoming State Water Plans. State, local government, and private agencies involved in developing water and related land resources of the basin should find useful information in this report. This report provides agencies of the U. S. Department of Agriculture with information to assess the value and impact of ongoing programs, the potential for project developments, and the need for accelerated or new programs to better meet the needs of the people and conserve the basin's natural resources.

The basin includes the hydrologic drainages of the Wind River, Bighorn River, Shoshone River, Clarks Fork River, Stillwater River, Little Bighorn River, all of their tributaries, and some south-side tributaries of the Yellowstone River between Columbus and Bighorn, Montana. The total area of the basin is 18,167,990 acres or about 28,390 square miles. About 72 percent of the area is in Wyoming and 28 percent in Montana. The Yellowstone River Compact of 1950 allocates the interstate waters between Wyoming and Montana except those in the Little Bighorn River.

This study has been made under the authority of Section VI of the Watershed Protection and Flood Prevention Act of the 83rd Congress (Public Law 566) as amended and supplemented. By this act the Secretary of Agriculture is authorized to cooperate with other federal, state, and local agencies in making investigations and surveys of watersheds and rivers as a basis for development of coordinated programs. The State Engineer of Wyoming and the Montana Department of Natural Resources and Conservation have both requested this study and participated in it.

Data for this study were compiled, analyzed, and presented by employees of the Soil Conservation Service, Forest Service, and Economic Research Service with additional data and cooperation provided by other state and federal agencies. Table I-1 is a list of contributing federal and state agencies. Data, assistance, cooperation, and recommendations received from all other agencies are greatly appreciated.

The information presented in this report is generalized to describe the entire river basin. More detailed information for each state is available in the Montana and Wyoming supplements to this report.

Table I-1--Contributing agencies

U. S. Department of Agriculture

- Soil Conservation Service
- Forest Service
- Economic Research Service
- Agricultural Stabilization and Conservation Service
- Farmers Home Administration
- Rural Electrification Administration
- Cooperative Extension Service
- Statistical Reporting Service

State agencies

- Wyoming
  - Wyoming State Engineer
    - Wyoming Water Planning Program
  - Department of Agriculture
  - Department of Economic Planning and Development
  - Department of Environmental Quality
    - Water Quality Division
  - Wyoming State Forestry Division
  - Game and Fish Department
  - Wyoming Recreation Commission
  - University of Wyoming

- Montana
  - Department of Natural Resources and Conservation
  - Fish and Game Department
  - Department of Health and Environmental Sciences
  - Department of State Lands and Investments
  - Division of Planning and Economic Development
  - Bureau of Mines and Geology
- Other federal agencies
  - Bureau of Indian Affairs
  - Bureau of Reclamation
  - Bureau of Land Management
  - Bureau of Sport Fisheries and Wildlife
  - Geological Survey
  - National Park Service
  - National Weather Service
  - Bureau of Public Roads

II. NATURAL RESOURCES OF THE BASIN

The relative amounts of natural resources available in a river basin have a major influence on the economic and cultural activity in the basin. Consideration must be given to location, climate, physiography, geology, soils, hydrology, plants, animals, scenic values, and other factors of the natural environment to properly plan for balanced resource development. The quantity, quality, and value of each of these natural resources affects the use and development of the other resources. This chapter contains inventories and descriptions of many of the natural resources of the basin.

LOCATION AND SIZE

The Wind-Bighorn-Clarks Fork River Basin lies in north-central Wyoming and south-central Montana extending from south of Lander, Wyoming, north to Bighorn, Montana. Yellowstone National Park shares some of the boundary on the west side of the basin, and the Bighorn Mountains form much of the eastern boundary. Most of the basin lies between the 42nd and 46th degree parallels (about halfway from the equator to the north pole) and the 107th and 110th degrees longitude, along the east flank of the Rocky Mountain Range. The basin area is about 28,390 square miles and includes about 21 percent of Wyoming and about 5 percent of Montana. About 72 percent of the basin is in Wyoming and 28 percent is in Montana. Figure II-1 is a map of the basin showing its location and counties involved in Montana and Wyoming. Table II-1 lists areas of major subbasins in the basin.

CLIMATE

The climate of the basin ranges from cool, semiarid deserts in the central floor of the basin, through a cool subhumid climate on the mountain sides, cold taiga,[1/] and very cold tundra to limited areas of perpetual frost and glaciers on the high mountains. The climate is more closely related to elevation than to latitude, and the elevation ranges from less than 3,000 feet at Bighorn, Montana, to almost 14,000 feet at Gannet Peak in the Wind River Mountains.

Precipitation varies both with elevations and location. A map of estimated average annual precipitation, developed from precipitation gage records, snow course records, precipitation-elevation curves, and a hydrologic simulation model, is presented in figure II-2. Precipitation in the mountains increases with elevation. Since much of the southern portion of the basin is surrounded by high mountain ranges, which wring most of the available moisture from approaching air masses, the lower central portions of the basin are deserts. The plains north of the Bighorn Mountains suffer

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1/ Taiga is a cold, coniferous forest, mainly spruce and alpine fir, occurring in polar regions and on mountain slopes below the tundra province. Tundra is the even colder region with moss, lichens, and sedges.

Table II-1—Areas of major subbasins

Subbasin name	Area in Wyoming	Area in Montana	Total	Portion of total area
	acres			percent
Wind River	4,992,740	0	4,992,740	27
Bighorn River	7,196,060	1,763,010	8,959,070	49
Clarks Fork River	796,570	976,330	1,772,900	10
Little Bighorn River	193,670	637,720	831,390	5
Stillwater River		676,680	676,680	4
Yellowstone Minor Drainages		935,210	935,210	5
Total	13,179,040	4,988,950	18,167,990	100
Percent of total	72	28	100	100

less from this influence and receive more precipitation annually than some higher elevation areas farther south. Deep snowpacks develop in the mountains from fall, winter, and spring snows and melt in the spring to provide the most important source of streamflow in the basin.

Temperature varies more as a result of changes in season, vertical temperature inversions, and movements of air masses than from elevation. However, elevation is an important influence, and growing seasons are shorter as the elevation increases. Samples of recorded temperature extremes are -51° F. and 114° F. at Basin, Wyoming. The average annual growing season ranges from less than 60 days above 7,000 feet in elevation to 160 days or more near Basin, Wyoming; Billings, Montana; and at other locations less than 3,500 feet in elevation. Summers are warm, autumns are cool and pleasant, winters are cold, with some very cold spells in December and January, and spring is cool with frequent snows, rainstorms, and freezing spells.

Floods occur from a variety of causes. Warm rain on wet snowpacks in late winter and in the spring can cause extensive flooding. Rapid melting of mountain snowpacks in late spring causes general flooding along the larger streams. High intensity rainstorms often flood local areas in spring and summer. Alternate freezing and thawing can also cause ice jam flooding on large streams in late winter and early spring.

Evaporation rates are moderately high because of low relative humidity, high rates of wind, and a high percentage of days with sunshine.

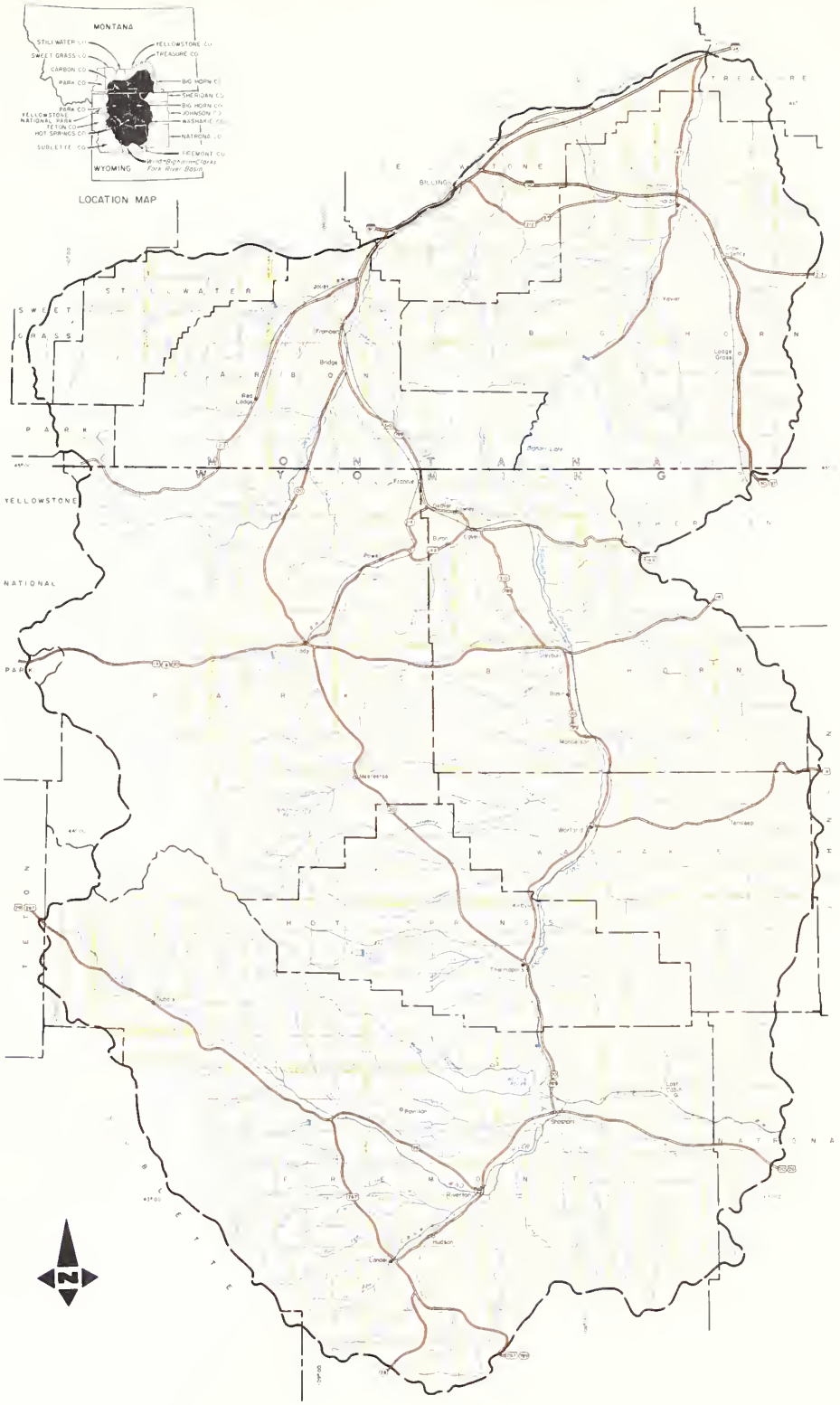


FIGURE 11-1

PROJECT MAP

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

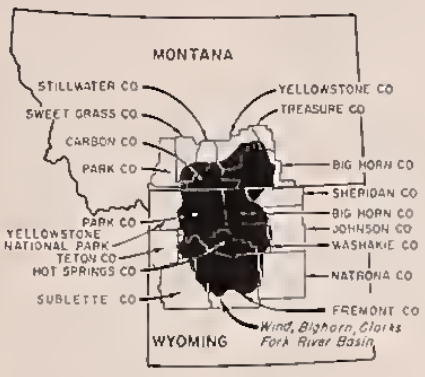
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

USDA-SCS-PORTLAND, OREG. 1975

M7-OL-22441A



LOCATION MAP

LEGEND

Average Annual Precipitation

- 0 to 10 inches
- 10 to 20 inches
- 20 to 40 inches
- 40 to 60 inches
- Over 60 inches

FIGURE II-2

AVERAGE ANNUAL PRECIPITATION

WIND · BIGHORN · CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-EN-22441B



Winter lays a heavy blanket of snow on the mountains.



Soil moisture from snowmelt nourishes plants and animals in the spring.

PLATE 1



The deeply incised Bighorn Canyon now holds the water of Bighorn Lake. This magnificent scenic area, once very difficult to enter, can now be easily seen from a boat.

BUREAU OF RECLAMATION PHOTO

The Wind River Canyon--geologist's textbook, camper's delight, scenic wonder, and fisherman's paradise.

BUREAU OF RECLAMATION PHOTO





This basin produces an important part of the nation's oil supply.

PLATE 2

PHYSIOGRAPHY AND GEOLOGY

This river basin lies within the Northern Rockies and Great Plains physiographic provinces. It includes portions of the Wyoming-Bighorn Basins, Middle Rocky Mountains, and Upper Missouri Broken Lands physical subdivisions of land surface forms in the United States.[1] Mountain ranges bounding the basin on the west side include the Beartooth, Absaroka, and Wind River Mountains. The Bighorn Mountains form part of the eastern boundary. The Owl Creek and Bridger Mountains divide the Wind River and Bighorn River Subbasins in the south, and the Pryor Mountains are within the basin near the state line.

There are five major subbasins drained by the Wind, Bighorn (including the Shoshone River), Clarks Fork, Stillwater, and Little Bighorn Rivers. The rivers that drain these subbasins are primarily consequent[2] streams that have cut deep canyons through the highlands. Two of these are particularly scenic. One is the Wind River Canyon where the Wind-Bighorn River divides the Owl Creek and Bridger Mountains. The other is located along the southeast end of the Pryor Mountains where the deeply incised Bighorn Canyon now holds the waters of the Bighorn Lake. This magnificent canyon was relatively inaccessible before the construction of Yellowtail Dam. Many miles of the canyon's sandstone and limestone cliffs can now be reached by boat.

The major features of the basin are interspersed timbered foothills, dissected lesser plateaus, sharp ridges, rugged badlands, and terraced river valleys. The wide range in erosion resistance of the underlying rock layers is the principal factor in the development of these features. The more resistant rocks stand as erosional remnants or in high relief while the softer rocks have been eroded into open valleys. The precipitous canyons were cut into durable rock over a prolonged period by swift-flowing streams.

Much of the rugged high mountain lands have been designated as wilderness, primitive areas, or roadless areas; but the car-bound tourist can glimpse some of this wonderland on the few roads that traverse the mountains when entering the basin and Yellowstone National Park.

The geologic history of the basin is a complex record of uplift, igneous intrusion, folding, faulting, erosion, and sedimentation. Formations range in age from Precambrian to Quaternary with all the intervening ages except the Silurian being represented. Crystalline rocks of the Precambrian Age are exposed along the high mountain divides, except in the Absaroka Mountains which are composed of volcanic extrusive and intrusive rocks of Tertiary Age. Paleozoic and Mesozoic sedimentary rocks occur around the flanks of the basin. The floor of the basin contains sedimentary rocks of Tertiary Age, and unconsolidated alluvium of Quaternary Age occurs along the river valleys.

1/ The National Atlas of the United States of America, pp. 60-61, USDI, Geological Survey, 1970.

2/ Having a course controlled by the basin's topography.

Several periods of movement of the earth's crust took place in the basin during Precambrian time. This faulting and folding played a major role in determining the present form of the basin. The area was generally quiet during Paleozoic and Mesozoic time. This relatively inactive period ended with the start of the Laramide orogeny which reached its peak in the late Paleocene to early Eocene time. This was closely followed by volcanic activity along the northwest margin of the basin. The basin was then filled with sediments to nearly a plain with only the core of the mountains protruding above the plain. The area was then upwarped and faulted. This caused rejuvenated erosion resulting in canyon cutting and excavation of the basin. Local volcanic activity also occurred at this time. Subsequent alpine glaciation and erosion have modified the basin into its present form. Figure II-3 is a generalized geology map of the basin.

MINERAL RESOURCES

Petroleum, natural gas, uranium, iron, bentonite, gypsum, clay, sand, gravel, limestone, and sulfur are presently the most important mineral resources in the basin. Current annual oil and natural gas production is about 70 million barrels of oil and about 75 billion cubic feet of natural gas from fields scattered throughout the basin. About 2,000,000 tons of uranium ore are processed annually, primarily in the Gas Hills area in the southeast part of the basin. An iron mill on the basin boundary southwest of Lander processes about 4,000,000 tons of raw iron ore per year. About 875,000 tons of bentonite are produced annually in the Greybull area. About 350,000 tons of gypsum per year are produced near Cody and Lovell. Clay is processed for tile in the Lovell area, limestone is quarried near Warren, and feldspar is being mined on Copper Mountain near Boysen Reservoir. Sands and gravels for concrete are produced at several locations in the basin.

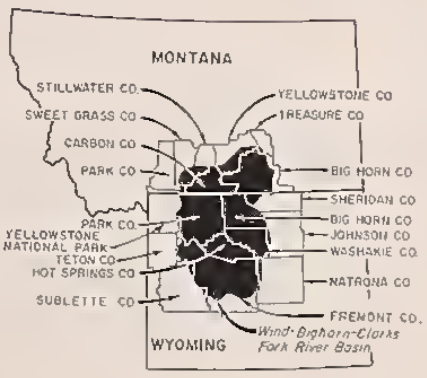
Other minerals are available in the basin. Significant reserves of good grade bituminous coal occur, but development is limited to small amounts for local use. Increased development is not expected in the near future because of the abundance of more easily mined coal in adjacent river basins to the east. Large deposits of low grade chromite exist in southern Stillwater County. These were mined during World War II, but the chromium ore cannot presently be produced as economically as it can be imported. Copper, nickel, and platinum are associated with these deposits. Gold, silver, and lead are also found in the basin. Sandstone of building quality is available.

LAND RESOURCES

Land is one of the basic resources used by man and is the most common resource in private ownership. The value of land for agricultural use varies with its productive capacity. This potential capacity is dictated by soils type, climate, vegetative cover, and, in this semiarid

LEGEND

- Qal – Quaternary Alluvium
- Qt – Quaternary Terrace
- Ti – Tertiary Intrusive Volcanics
- Te, Te-Ke – Tertiary Extrusive Volcanics
- Tmo – Miocene & Oligocene Undivided
- Teum – Upper & Middle Eocene Rocks Undivided
- Twr – Tertiary Wind River Formation
- Tw – Tertiary Wasatch Formation
- Tfu – Tertiary Fort Union Formation
- Klmv, Khc, Kl, Kb, Kjr, Kcl, Ke – Cretaceous Lance, Meeteetse, Mesaverde, Heli Creek, Lennep, Beorpaw, Judith River, Claggett and Eagle Formations
- Kc, Ktc, Kft – Cretaceous Colorado Group
- K – Cretaceous Cloverly, Morrison Fms.
- J – Jurassic Rocks Undivided
- Tr – Triassic Rocks Undivided
- IPp – Pennsylvanian & Permian Rocks Undivided
- Cm – Mississippian Undivided
- D-C – Devonian to Cambrian Rocks Undivided
- pC – Pre-Cambrian Granite
- Fault
- Inferred Fault
- Inverted Fault
- Inferred Contact



LOCATION MAP

FIGURE II-3

GENERALIZED GEOLOGY

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

area, the availability of water. Land ownership, soils, vegetative cover, and land use are described in this section.

Land ownership and administration

The ownership and administration pattern of land in the basin has a considerable effect on land resource development. Table II-2 lists major areas of land ownership in the basin. Figures II-4A and II-4B are land ownership and administration maps for the Montana and Wyoming portions of the basin. Nearly half of the area is in federal ownership and administration. Twenty percent of the area is in national forests, and 26 percent of the area is in range and forest lands administered by the Bureau of Land Management. About 38 percent of the land classified as private in this report is Indian trust land in the Wind River and Crow Indian Reservations. The comparison of this with other private ownership is deceptive, however, because much of the reservation land is of the type that otherwise would be national forests and public rangelands. Only about 10 percent of the irrigated cropland in the basin has been developed on reservation lands. Much of the national forest is in wilderness, primitive, or roadless areas.

Soils

The wide variety of soils in the basin is due to the several kinds and origins of the parent materials, to variations in climatic conditions, and the effects of different kinds of vegetation. Soils in the basin have been grouped into generalized associations shown on the generalized soil map of figure II-5.

Vegetative cover

Vegetative cover is described here in terms of vegetative aspect. This is defined as the visually dominant kind of vegetation in a vegetated area, such as grass, brush, trees, irrigated crops, nonirrigated crops, or alpine vegetation. Barren areas, water surfaces, and urban and built-up areas were also included in this inventory. Figure II-6 is a map of vegetative aspects in the basin.

Table II-3 lists areas of vegetative aspect and land use. More than 70 percent of the basin area is brush and grassland. About 15 percent of the area is in trees and about 6 percent in cropland. The rest of the area is in water, alpine areas, barren lands, and urban and built-up areas.

Land use

Land use is influenced by vegetation, climate, soils, ownership, and availability of water. Major land uses are described briefly here. Additional detailed information is found in chapter III.

Irrigated cropland

There are about 770,250 acres of irrigated cropland in the basin.

Table II-2--Surface ownership and administration in the Wind-Bighorn-Clarks Fork River Basin, January 1972[1/]

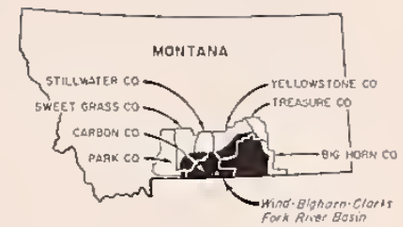
State	Ownership or administration							
	Private		State		Federal			
	Private ownership	Indian trust lands	Game and Fish Commissions	Other state	Bureau of Land Management	National forest	Bureau of Reclamation	Other federal agencies
	acres		acres		acres			
Wyoming	2,702,660	1,953,100[2/]	19,960	584,340	4,426,150	3,025,590	412,350	54,890
Montana	2,491,530	1,464,800	1,170	122,480	215,030	659,190	10,920	23,830
Total	5,194,190	3,417,900	21,130	706,820	4,641,180	3,684,780	423,270	78,720
Percent of total	29	19	* [3/]	4	26	20	2	*
Total by classification		8,612,090		727,950				8,827,950
Percent by classification		48		4				48

1/ Includes water and total land area.

2/ This may include some land in private non-Indian ownership. The BIA data for this area is 1,885,080 acres.

3/ * means less than 0.5 percent.

Compiled from area measurements on maps and data from land adminstering agencies.



LOCATION MAP

LEGEND

- Public Lands
- Acquired Lands
- Indian Reservations
- National Forests
- National Parks, Monuments
- State Lands
- Private Lands

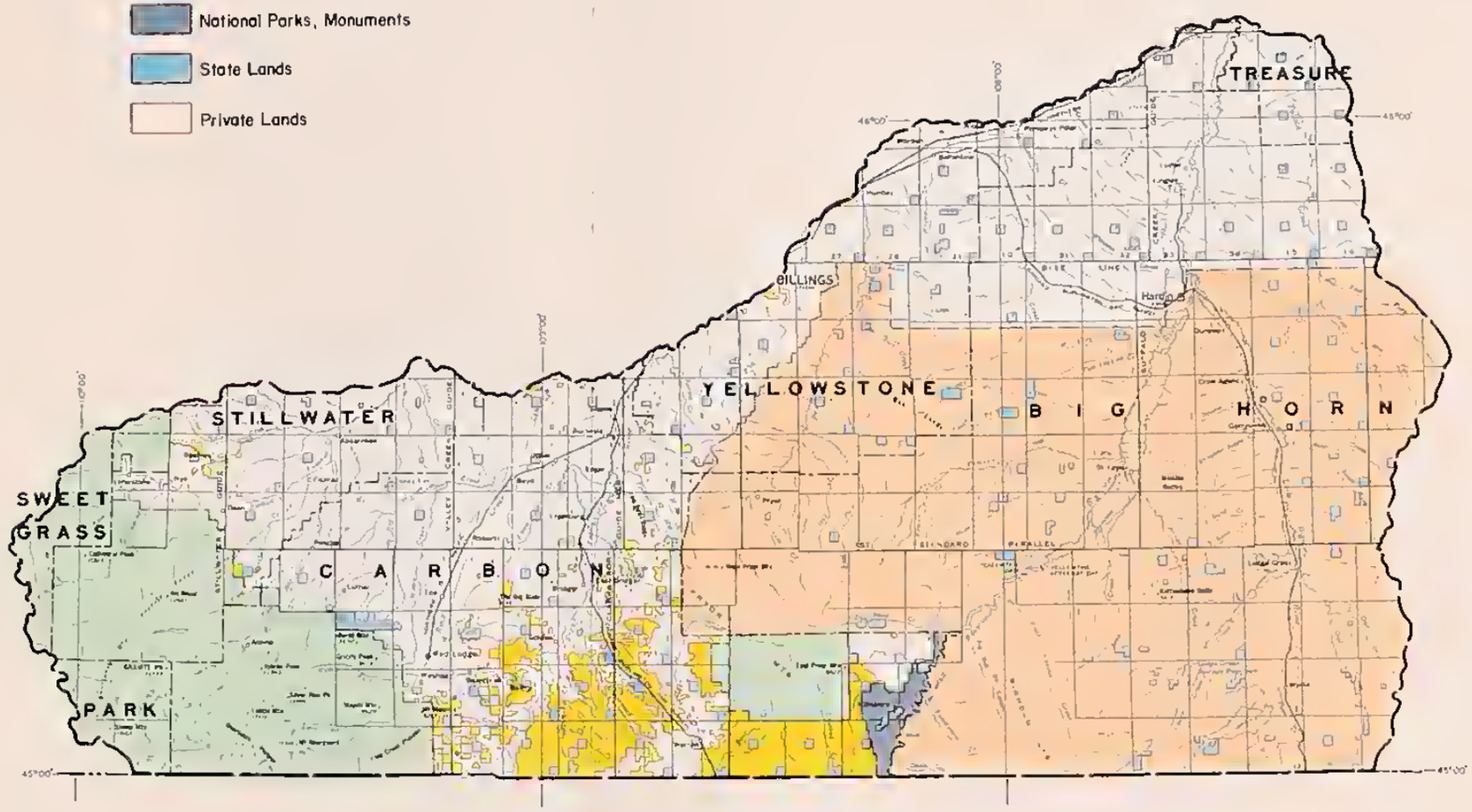


FIGURE II-4A

LAND OWNERSHIP & ADMINISTRATION

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA

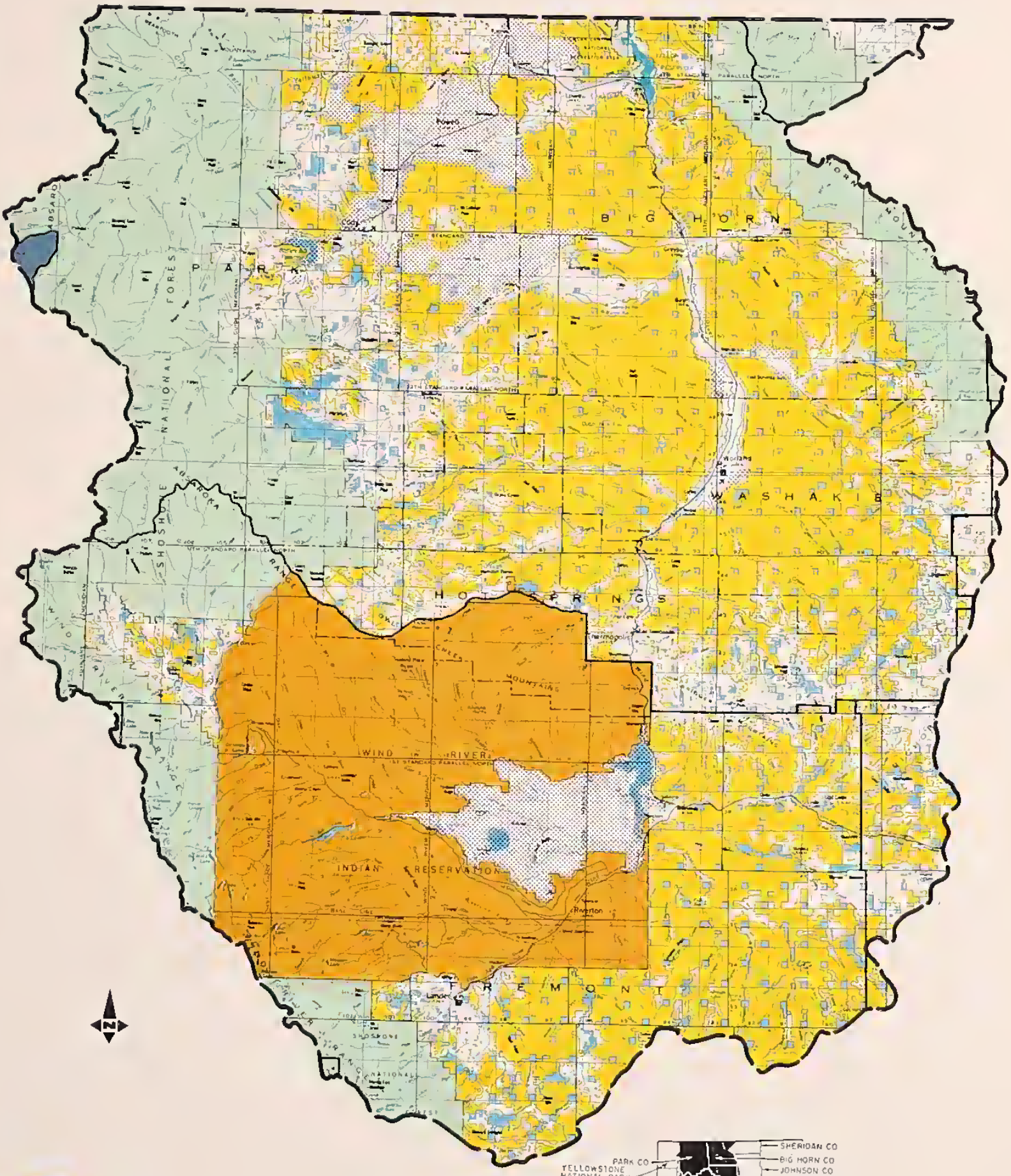
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

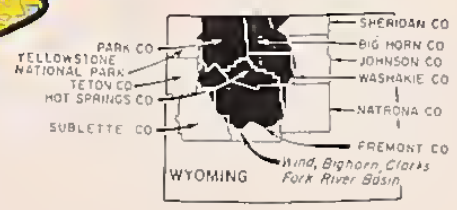
DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

M7-EN-22441E





LOCATION MAP

- Public Lands
- National Parks and Monuments
- B. L. M. Aquired Land
- Indian Reservation
- State Lands
- Private Lands
- National Forests
- Bureau of Reclamation Jurisdiction
- Prior Mountion Wild Horse and Wildlife Range
- National Recreation Areas

FIGURE 11-48

LAND OWNERSHIP & ADMINISTRATION

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,100,000

LEGEND

SOILS OF THE MOUNTAINS, MOUNTAIN VALLEYS AND MOUNTAIN FOOTHILLS

C-1 Cryoborolls-Cryoboralfs-Rock outcrop association: steep and very steep, shallow and moderately deep, well-drained soils and rock outcrops on tops and sides of mountains.

C-2 Cryoboralfs-Rock outcrop association: steep and very steep, shallow to deep, well-drained soils on sides and foothills of mountains.

C-3 Cryoborolls-Rock outcrop association: steep, shallow to deep, well-drained soils on dissected mountain fronts and rounded knolls and ridges of mountains.

C-4 Cryanthents-Cryoborolls association: nearly level to steep, shallow to deep, well-drained soils on terraces and fans in valleys and on dissected uplands of the mountains.

SOILS OF THE MOUNTAIN FOOTHILLS AND DESERTIC BASINS

F-1 Haplargids-Argiborolls association: nearly level to steep, deep, well-drained soils on terraces, fans and till plains of the mountain foothills.

F-2 Haplargids-Camborthids-Torriorthents association: rolling and steep, shallow to deep, well-drained soils on dissected mountain foothills and on uplands in desertic basins.

F-3 Torriorthents-Rock outcrop association: rolling and steep, shallow to deep, well-drained soils on mountain foot slopes.

F-4 Haplargids-Torriorthents association: rolling and steep, shallow to deep, well-drained soils on mountain foothills and on uplands in desertic basins.

F-5 Ustorthents association: rolling and steep, shallow to deep, well-drained soils on dissected mountain foothills.

F-6 Ustorthents-Argiborolls-Haploborolls association: nearly level to very steep, shallow to deep, well-drained soils on mountain foothills.

F-7 Ustifluvents-Argiborolls-Haploborolls association: nearly level to rolling, deep, well and moderately well-drained soils on flood plains, terraces and fans on mountain foothills.

F-8 Ustorthents-Argiborolls association: rolling and steep, shallow to deep, well-drained soils on mountain foothills.

F-9 Haplargids association: nearly level to rolling, deep, well-drained soils on terraces and uplands of desertic basins.

SOILS OF THE DESERTIC BASINS AND UPLANDS

M-1 Haplargids-Torrifluvents-Torriorthents association: nearly level to sloping, deep, well-drained soils on terraces and fans of desertic basins.

M-2 Torriorthents-Camborthids association: nearly level to steep, shallow to deep, well-drained soils on uplands of desertic basins.

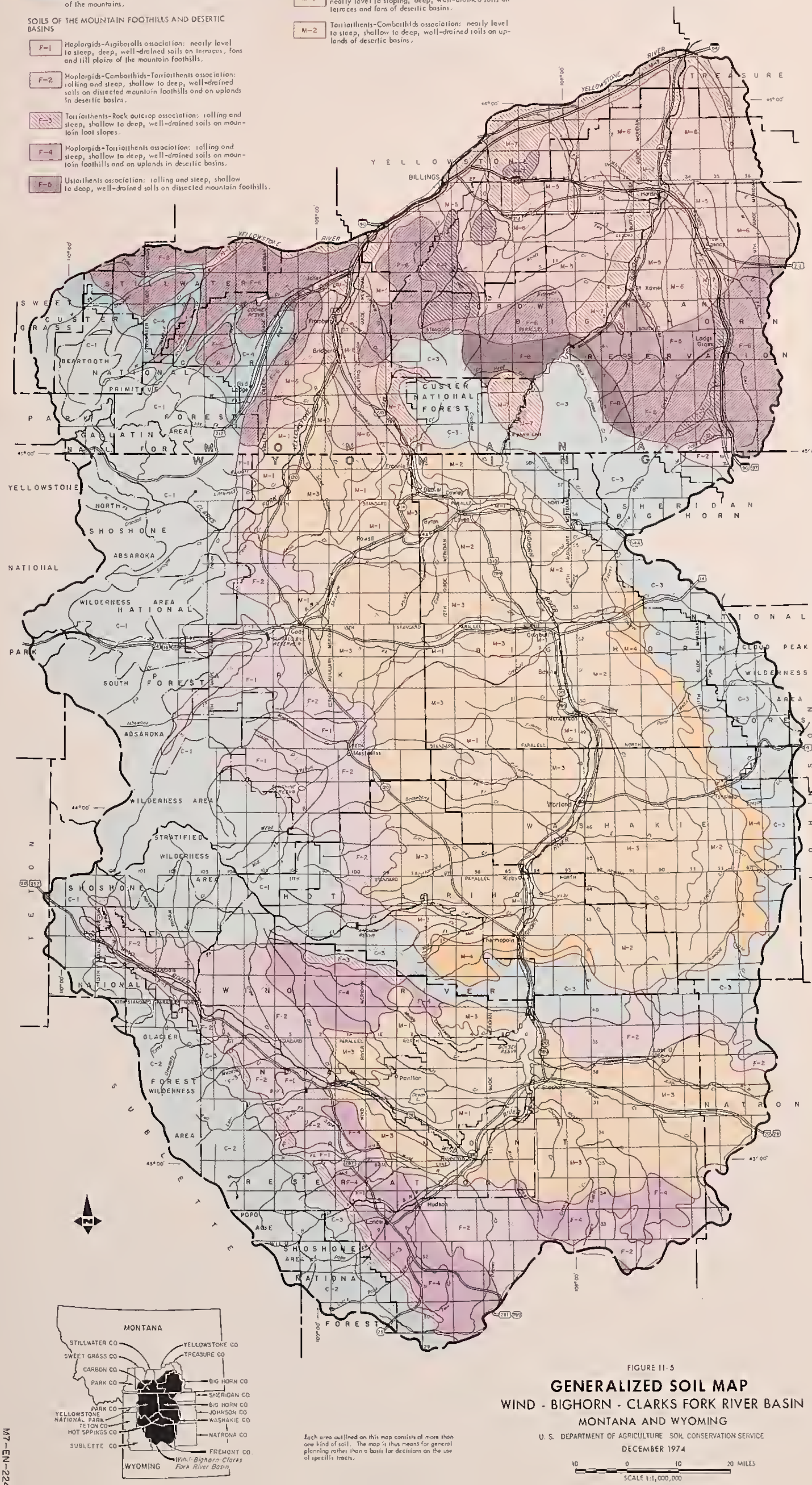
M-3 Haplargids-Natrargids-Torriorthents association: undulating to steep, shallow to deep, well-drained soils in desertic basins and on uplands.

M-4 Camborthids-Torriorthents association: rolling and steep, shallow to deep, well-drained soils on dissected uplands in desertic basins.

M-5 Torriorthents association: nearly level to steep, shallow to deep, well-drained soils on uplands.

M-6 Haplargids-Torriorthents-Argiustolls association: nearly level to very steep, shallow to deep, well-drained soils on dissected uplands.

M-7 Haplargids-Torrifluvents-Torriorthents association: nearly level to sloping, deep, well-drained soils on flood plains, terraces and fans in uplands.



Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

FIGURE II-5

GENERALIZED SOIL MAP

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

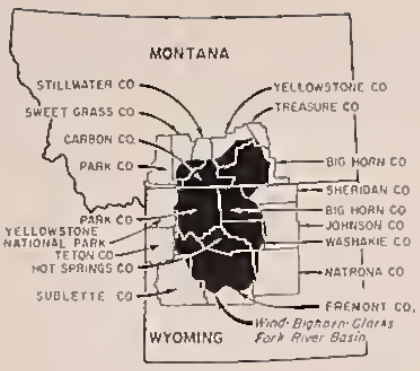
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

M7-EN-2244



LOCATION MAP

VEGETATIVE ASPECT

- Alpine
- Barren
- Brush
- Crop
- Grass
- Trees
- Water

FIGURE II-6

VEGETATIVE ASPECT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-EN-2244IF

Table II-3---Vegetative aspect and land use by sub-basin and states in the Wind-Bighorn-Clarks Fork River Basin

Sub-basin name	Water	Grass	Irrigated cropland	Non-irrigated cropland	Trees	Brush	Alpine and barren	Urban and built-up	Total
	acres								
Wind River	38,890	428,740	195,770	0	676,460	2,904,050	748,040	790	4,992,740
Bighorn River in Wyoming	28,480	1,362,210	329,500	0	951,250	4,259,530	261,760	3,330	7,196,060
Bighorn River in Montana	12,970	1,308,180	56,460	95,940	202,510	76,020	1,690	9,240	1,763,010
Subtotal for Bighorn River	41,450	2,670,390	385,960	95,940	1,153,760	4,335,550	263,450	12,570	8,959,070
Clarks Fork River in Wyoming	2,880	255,240	11,120	0	235,310	231,380	60,640	0	796,570
Clarks Fork River in Montana	9,530	459,520	88,630	75,490	105,000	171,980	54,840	11,340	976,330
Subtotal for Clarks Fork River	12,410	714,760	99,750	75,490	340,310	403,360	115,480	11,340	1,772,900
Little Bighorn in Wyoming	50	36,510	2,440	4,070	107,860	38,580	4,150	10	193,670
Little Bighorn in Montana	1,400	499,720	17,130	49,680	59,170	0	3,390	7,230	637,720
Subtotal for Little Bighorn	1,450	536,230	19,570	53,750	167,030	38,580	7,540	7,240	831,390
Stillwater River	3,960	373,340	29,250	19,820	212,080	0	33,700	4,530	676,680
Yellowstone minor drainages	2,020	668,350	39,950	103,630	110,260	0	0	11,000	935,210
Total Wyoming	70,300	2,082,700	538,830	4,070	1,970,880	7,433,540	1,074,590	4,130	13,179,040
Total Montana	29,880	3,309,110	231,420	344,560	689,020	248,000	93,620	43,340	4,988,950
Total river basin	100,180	5,391,810	770,250	348,630	2,659,900	7,681,540	1,168,210	47,470	18,167,990
Percent of total	1	30	4	2	15	42	6	0	100

These have been inventoried according to water supply, water delivery system, and common management practices into five types. Type I irrigated croplands have well developed systems, water supply, and water management practices and, therefore, generally produce the higher valued crops in the basin. Type II lands use systems similar to type I lands, but the systems are less well developed. Water supplies are generally short during much of the irrigation season. The systems are often designed for recycling tailwater flows, but on-field application efficiencies are quite low. Type III lands are commonly called mountain meadows. The systems are designed to take high rates of flow during the spring snowmelt season, but the lands are often short of water late in the growing season. Field application efficiencies are low. Type IV lands have special waterspreading systems. Dikes are often used in conjunction with large delivery ditches to divert, pond, and release flood flows whenever they occur during the year. In some years there may be no irrigation at all. Type V irrigated lands receive water only incidentally as a result of the irrigation of other lands. The vegetation is mainly grass used for hay and pasture. They have no irrigation systems and no significant irrigation water management. No type V lands were inventoried in the Montana portion of the basin. Table II-4 lists areas of irrigated cropland by type. Nearly all irrigated cropland in the basin is privately owned, including that portion within Indian Reservation boundaries.

Table II-4--Irrigated lands by type of irrigation, 1970

Sub-basin name	Type					
	I	II	III	IV	V	Total
	acres					
Wind River	73,160	91,060	5,660	7,320	18,570	195,770
Bighorn River in Wyoming	155,720	150,900	2,800	13,670	6,410	329,500
Bighorn River in Montana	34,910	19,660	1,660	230	0	56,460
Subtotal for Bighorn River	190,630	170,560	4,460	13,900	6,410	385,960
Clarks Fork River in Wyoming	2,700	5,350	1,960	1,110	0	11,120
Clarks Fork River in Montana	49,970	38,620	40	0	0	88,630
Subtotal for Clarks Fork River	52,670	43,970	2,000	1,110	0	99,750
Little Bighorn in Wyoming	0	1,190	800	450	0	2,440
Little Bighorn in Montana	3,680	13,310	140	0	0	17,130
Subtotal for Little Bighorn	3,680	14,500	940	450	0	19,570
Stillwater River	1,500	19,560	8,190	0	0	29,250
Yellowstone minor drainages	24,380	15,220	120	230	0	39,950
Total Wyoming	231,580	248,500	11,220	22,550	24,980	538,830
Total Montana	114,440	106,370	10,150	460	0	231,420
Total river basin	346,020	354,870	21,370	23,010	24,980	770,250
Percent of total	45	46	3	3	3	100



Soil scientists obtain basic soils information.



Knowledge about his soil is essential to the successful rancher.

PLATE 3



Surface water from mountain snowmelt is diverted in the summer to irrigate croplands.

Grass or brushland range is the most extensive land use in the basin.





Forest land is defined as land at least 10 percent stocked by trees of any size.

U.S. FOREST SERVICE PHOTO

Nonirrigated croplands

There are only about 4,070 acres of nonirrigated cropland in the Wyoming portion of the basin. All of these lands are in the northeast corner of the basin. There are about 344,560 acres in the Montana portion of the basin. This represents 60 percent of the total cropland in this area. (See table II-3.) Grains are the most important crops on these lands, but nearly half of this land is fallow each year. This rotation is required to build up the soil moisture needed to raise the crops.

Rangeland

Most of the brush and grass lands and some of the land with trees is used for livestock grazing and is considered rangeland. The privately-owned portion is used and managed for this primary purpose. The publicly-owned portion is usually leased for grazing and managed for multiple uses. Range condition is an indicator of production at a given location. Range conditions on private grass and brush lands are about 20 percent excellent, 55 percent good, 20 percent fair, and 5 percent poor. Production varies between locations because of precipitation, growing season, soils, and management. Much of the rangeland in the basin is low in production because of low precipitation, poor seasonal distribution of precipitation, and short growing season.

Forest land

In this report, forest land is not defined as land with trees. Forest land is land at least 10 percent stocked by trees of any size and capable of producing timber or other wood products or of exerting significant influence on climate and water regimes. However, lands from which trees have been removed to less than 10 percent stocking which have not been developed for other uses are still defined as forest lands. Table II-5 lists areas of commercial and noncommercial forest land by stand size class and ownership. A comparison with table II-3 shows that in Montana there are more tree-covered lands than forest lands. In Wyoming there are more forest lands than tree-covered lands.

Commercial forest land is land which is producing, or is capable of producing, an economically usable harvest of wood (usually at least 20 cu. ft./acre/yr.) and is not withdrawn or reserved from cutting. There are about 1,444,470 acres of commercial forest land in the basin. About 76 percent of this is in national forests. About 87 percent of the area has timber larger than 5 inches in diameter and suitable for poles or sawtimber. About 11 percent of the area has trees classified as seedlings and saplings. However, much of the small timber, including poletimber, is comprised of stagnated stands. These stands are relatively old and will not grow significantly even if thinned. These are softwood forests, and the use of timber does not depend on the species available to a significant degree.

Table II-5--Forested land area by stand size class and ownership, 1971 [1/]

	Total area			National forest		Public domain		Indian reservation		State and private		Yellowstone National Park
	Basin	Wyoming	Montana	Wyoming	Montana	Wyoming	Montana	Wyoming	Montana	Wyoming	Montana	(Wyoming)
Commercial forest												
Sawtimber	824,980	719,900	105,080	475,200	53,270	15,600	0	33,000	21,050	196,100	30,760	0
Poletimber	429,780	364,500	65,280	361,000	42,450	3,500	0	2/	2,620	N/A 3/	20,210	0
Seedlings and saplings	165,410	66,100	99,310	61,000	82,610	100	0	5,000	290	N/A	16,410	0
Nonstocked	23,000	23,000	0	23,000	0	0	0	N/A	0	N/A	0	0
Unclassified commercial	1,300	0	1,300	0	0	0	1,300	0	0	0	0	0
Subtotal - commercial	1,444,470	1,173,500	270,970	920,200	178,330	19,200	1,300	38,000	23,960	196,100	67,380	0
Noncommercial and reserved 4/	1,473,420	1,128,200	345,220	795,800	126,690	1,000	7,900	169,000	53,650	144,200	156,980	18,200
Total forested land	2,917,890	2,301,700	616,190	1,716,000	305,020	20,200	9,200	207,000	77,610	340,300	224,360	18,200

1/ See text for definition of forested land.

2/ Poletimber area included in sawtimber area on the reservation.

3/ N/A means data is not available.

4/ Stand size class not available for noncommercial and reserved forest land. Reserved areas include designated wilderness and primitive areas.

Other lands

About 6 percent of the basin is in barren, alpine, or urban and built-up areas. Most, if not all, of the alpine areas are in designated wilderness or primitive areas at elevations about 10,000 feet. They are very important as water yielding areas and some are covered with glaciers. The vegetation is either taiga or tundra. Barren lands at lower elevations lack vegetation primarily because of poor soils associated with natural geologic erosion. Urban and built-up areas include cities, towns, highways, roads, railroads, farmsteads, and other incidental land uses and include less than 0.3 percent of the total basin. Water areas listed in table II-3 include ponds, lakes, and reservoirs as small as 5 acres in size.

SURFACE WATER RESOURCES

Surface water supplies

Water resources available for use in the basin depend largely on the melting of high country snowpacks. Rainstorms in the basin and snowmelt from lower elevation lands also contribute to the total supply. Water yield to surface streams ranges from almost zero in some years at low elevations to more than 2,700 acre-feet per square mile per year (50 inches) from some high elevation lands. Figure II-7 is an average water yield map for the basin as developed in this study.

The seasonal distribution of streamflows is an important factor in its effect on the environment and the use of the water supply. Figure II-8 is a typical annual stream hydrograph for a stream with relatively little regulation. More water is available in the spring that can generally be used through direct diversion, and high waters in the spring sometimes cause flooding on lowlands along the streams. Streamflows decrease rapidly as the snowpack is depleted. There is generally a water supply deficit in late summer and early fall. Reservoirs reduce this effect by storing spring runoff for late summer use.

Table II-6 lists estimated annual streamflows at several locations in the basin for 50 percent and 80 percent chance years. The flow available in a 50 percent chance year is equaled or exceeded about 50 of each 100 years. The flow available in an 80 percent chance year is a smaller but more reliable flow exceeded about 80 of each 100 years. These data were obtained through analysis of stream gaging records supplemented by a river basin simulation computer model. Irrigation and phreatophyte depletion estimates are based on field and aerial photograph surveys of area and the modified Blaney-Criddle method of estimating consumptive use.

As you can see from table II-6, 26 percent or more of the total native water supply is depleted by irrigation in dry years. The impact of irrigation is even greater than this depletion estimate indicates. More than 50 percent of the total water supply is diverted for irrigation use. Practically all of the surface water resource is affected in some way by irrigation.

Table II-6--Estimated surface water resources of the Wind-Bighorn-Clarks Fork River Basin, 1970

Sub-basin	Phreatophyte area	Present area of irrigated land	50 percent chance: Total native water yield	50 percent chance: Flow from upstream sources or transfers 1/	50 percent chance: Phreatophyte depletion	50 percent chance: Reservoir effects and evaporation	50 percent chance: Available water supply 1/	50 percent chance: Irrigation depletion	50 percent chance: Remaining water supply 1/	80 percent chance: Total native water yield	80 percent chance: Flow from upstream sources or transfers 1/	80 percent chance: Phreatophyte depletion	80 percent chance: Reservoir effects and evaporation	80 percent chance: Available water supply 1/	80 percent chance: Irrigation depletion	80 percent chance: Remaining water supply 1/
	acres		acre-feet							acre-feet						
Wind River	76,020	195,769	1,492,200	0	148,200	82,800 2/	1,261,200	336,200	925,000	1,207,300	0	142,000	2,500 3/	1,062,800	322,800	740,000
Bighorn River in Wyoming	119,370	329,503	2,353,740	954,960	213,600	22,000 4/	3,073,100	677,100	2,396,000	1,939,270	759,930	203,600	22,000 3/	2,473,600	646,600	1,827,000
Little Bighorn in Wyoming	0	2,441	141,000	0	0	0	141,000	2,700	138,300	113,500	0	0	0	113,500	2,300	111,200
Little Bighorn in Montana	8,690	17,134	109,400	138,300	44,760	1,200	201,740	27,590	174,150	86,520	111,200	44,760	1,000	151,960	27,590	124,370
Bighorn River in Montana	10,550	56,454	164,920	2,570,150	66,690	26,000 5/	2,642,380	87,380	2,555,000	73,700	1,951,370	66,690	20,000 5/	1,938,380	87,380	1,851,000
Upper Clarks Fork in Montana	2,240	0	237,460	0	6,760	0	230,700	0	230,700	195,960	0	6,760	0	189,200	0	189,200
Clarks Fork River in Wyoming	3,010	11,119	458,100	230,700	7,700	0	681,100	21,100	660,000	399,500	189,200	7,700	0	581,000	21,000	560,000
Upper Rock Creek, Big Sand Coulee, and Elk Basin	0	0	36,500	16,700 6/	0	0	53,200	0	53,200	29,500	24,510 6/	0	0	54,010	0	54,010
Lower Clarks Fork in Montana	13,170	88,628	313,070	713,200	69,070	3,200	954,000	140,070	813,930	273,760	614,010	69,070	2,400	816,300	140,070	676,230
Stillwater River	4,760	29,252	850,400	0	18,760	0	831,640	63,500	768,140	701,380	0	18,760	0	682,620	71,310	611,310
Yellowstone minor drainages	3,790	39,951	98,630	4,813,930 7/	25,260	0	4,887,300	63,930	4,823,370 7/	69,560	4,076,230 7/	25,260	0	4,120,530	63,930	4,056,600 7/

1/ The data in these columns are for the sub-basins named and are not additive to obtain basinwide totals.

2/ Includes carryover storage in Boysen Reservoir as indicated by streamflow records from 1951 - 1970.

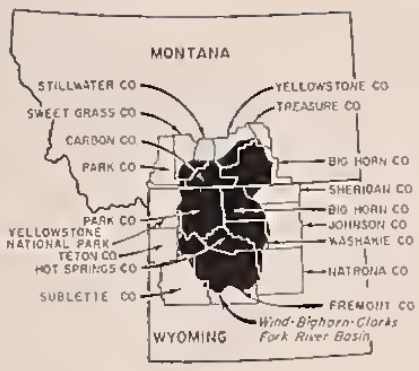
3/ Withdrawals from storage in dry years replaces some other losses as indicated by streamflow records from 1951 - 1970.

4/ Primarily evaporation from Buffalo Bill Reservoir.

5/ Primarily evaporation from Bighorn Lake.

6/ Diversion from Rock Creek.

7/ Includes the flow of the Yellowstone and Clarks Fork Rivers. Most of this flow is not diverted for irrigation, but is available for phreatophytes in watersheds along the Yellowstone River. These flows and the flow from the Bighorn River constitute most of the available water in the Yellowstone River at Bighorn, Montana.



LOCATION MAP

LEGEND

—30— Average Annual Water Yield in Inches

- Less than 1 inch
- 1 to 5 inches
- 5 to 20 inches
- 20 to 40 inches
- More than 40 inches

FIGURE II-7

AVERAGE ANNUAL WATER YIELD

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

*LEES FOSA AREA PROJECTION

M7-EN-2244(H

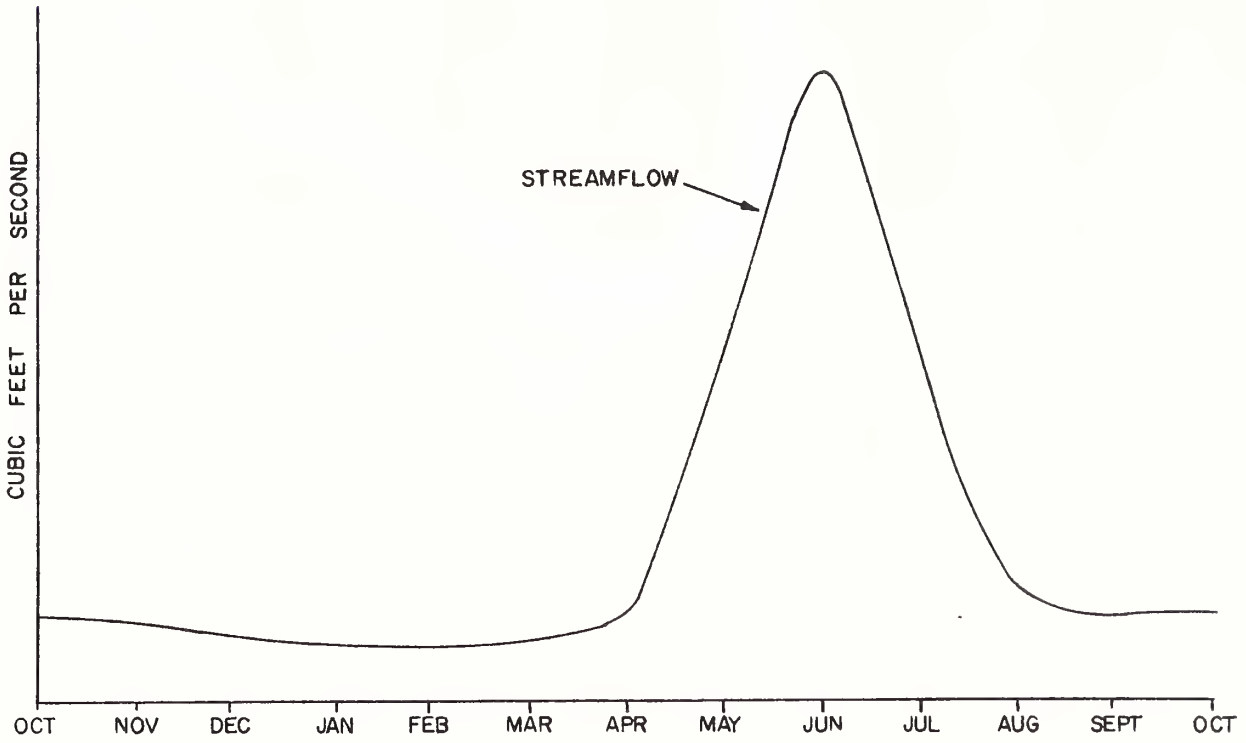


FIGURE II-8 -- TYPICAL ANNUAL STREAMFLOW HYDROGRAPH

About 10 percent of the surface water in the basin is depleted by phreatophytes. No discussion of the water resources of the basin can omit these uses.

This basin is a water surplus area in spite of important water shortages within the basin. The 50 percent chance annual flow of water from this basin to the Missouri River Basin system is about 4,200,000 acre-feet. About 70 percent is contributed from Wyoming, which has 72 percent of the basin area. Figure II-9 is a flow chart of the surface waters of the basin for a 50 percent chance water year.

The quality of the surface water resource is probably less than it was before the 19th century, but is still adequate for most uses in most parts of the basin. More discussion on water quality can be found at the end of this chapter.

Water surface areas

The free surface of open water is also a resource and is essential for many recreational activities. Table II-7 lists surface areas of lakes and ponds of more than 5 acres and total lengths of live streams and rivers in major subbasins.

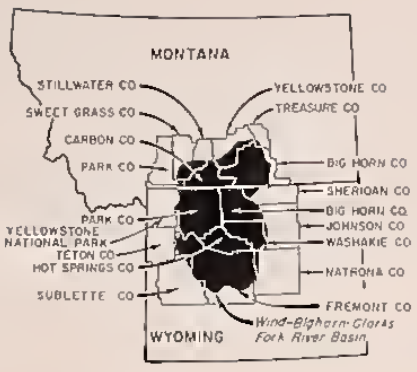
Glaciers

Glaciers in the Wyoming portion of the basin have a surface area of about 15 square miles. The Glacier Primitive Area, encompassing 176,303 acres, contains many of the area's glaciers, but others exist northward to the Clarks Fork River.

These glaciers are known as temperate glaciers and characteristically have a temperature of 32° F. throughout the pack, except during very cold weather. Temperate glaciers can produce much runoff. The estimated annual streamflow is 9 acre-feet per acre of glacier surface or 86,400 acre-feet for the entire 15 square miles.

The major agent of accumulation is snow that gradually changes into ice. Ablation, or loss of mass, occurs on temperate glaciers predominantly from melting. There is also loss from evaporation and sublimation. The fluctuation of melt water discharge in midsummer is pronounced, and the release is closely related to the amount of energy supplied by the sun and atmosphere. However, the correlation between daily temperatures and daily streamflows is not satisfactory. Further, the yearly total runoff does not necessarily equal the sum of precipitation plus condensation minus evaporation. The changes in both short and long-term trends relate to changes in storage. Cool, wet years favor accumulation and storage, while warm, dry years favor increased runoff.

There are probably ways to artificially modify melt rates from glaciers.



LOCATION MAP

WATER YIELD & DEPLETIONS (acre feet – 50% chance annual yield)

- 925,000 — General water flow pattern of major streams
- Mainstem of Yellowstone River
- Depletion of flow
- 336,000 / 231,000 — Irrigation depletion amount in acre-feet / Evaporation, phreatophyte, and other losses in acre-feet

FIGURE II-9

GENERALIZED SURFACE WATER FLOW CHART

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

Table II-7--Water surface areas and stream lengths by subbasin

Subbasin	Surface areas of ponds, lakes, and reservoirs	Length of live streams and rivers
	-----acres----	------miles------
Wind River	38,890	1,500
Bighorn River in Wyoming	28,480	4,300
Bighorn River in Montana	12,970	400
Subtotal for Bighorn River	41,450	4,700
Clarks Fork River in Wyoming	2,880	600
Clarks Fork River in Montana	9,530	410
Subtotal for Clarks Fork River	12,410	1,010
Little Bighorn River in Wyoming	50	100
Little Bighorn River in Montana	1,400	170
Subtotal for Little Bighorn	1,450	270
Stillwater River	3,960	340
Yellowstone minor drainages	2,020	130
Total Wyoming	70,300	6,500
Total Montana	29,880	1,450
Total river basin	100,180	7,950

However, artificial management of glaciers is not well developed in practice. Most of the glaciers are in wilderness areas. Natural and political restrictions on the use of motorized vehicles in these areas would likely make artificial management of the glaciers impractical.

GROUND-WATER RESOURCES

The availability of ground water within favorable drilling and pumping depths varies widely in aquifers in the basin. Where good quality ground water is available, it is used for domestic, industrial, irrigation, municipal, and livestock water supplies. Some aquifers hold water under pressure sufficient for artesian flows.

The quality and yield of ground water from a well varies primarily with the type of soil or rock in the aquifer that is tapped. The soil or rock can be identified by geologic formation. Shales are generally not aquifers. Sandstones are capable of moderate yields from 125 to 300 gallons per minute (gpm) or more. The Madison limestones and the Flathead sandstones are capable of large flows where they are cavernous or fractured. One well on Bluewater Creek in Montana flows 3,700 gallons per minute. Moderate yields are obtainable from alluvium formations in many locations. The greatest yields are obtained close to mountains where a greater abundance of coarser sands and gravels are found. Yields average about 300 gpm, but flows up to 2,000 gpm have been reported.

Figure II-10 is a map of the general availability of ground water. It shows the depth within which ground water may be expected. The yield that may be expected and its quality is also described. However, this map is generalized. Every location is geologically different and requires individual determination of the potential for gound water development. At some locations there may also be a serious conflict between ground and surface water rights. Figure II-11 provides references to specific publications which have more detailed ground water information.

FISH AND WILDLIFE RESOURCES

Low human population density, large areas of public lands, and wide variations in climate and vegetative cover contribute to relatively large populations of a wide variety of animal life.

Big game habitat

The habitat for big game ranges from rough alpine peaks and crags to vast grassland or sagebrush plains. Croplands, stream valleys, and deserts combine with the plains and mountain slopes as essential parts of the total area of big game habitat. Table II-8 lists big game species, the areas of their range, and their populations in each state. The condition of big game habitat in the basin is generally good. The most serious big game habitat limitation is winter range. Figure II-12 includes maps of habitat areas for deer, antelope, elk, moose, bighorn sheep, mountain goat, and bear. Mountain lion may also be hunted in some portions of the basin.

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

STRATIGRAPHIC LEGEND
FOR GENERAL AVAILABILITY OF GROUNDWATER MAP
WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA PORTION

AGE		FORMATION NAME	WATER BEARING PROPERTIES	EXPECTED YIELDS	1/ USUAL QUALITY
QUATERNARY		Valley Alluvium	Water Bearing	** 50 - 450+ gpm	Fair to Good
		River Terrace	Water Bearing	Less than 50 gpm	Fair to Good
TERTIARY	EOCENE PALEOCENE	Wasatch-Fort Union Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
		*Extrusive Pyroclastics	Non-Water Bearing		
CRETACEOUS	UPPER	Hell Creek Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
		Lennep Sandstone	Water Bearing	Less than 50 gpm	Fair to Good
		*Bearpaw Shale	Non-Water Bearing		
		Judith River Formation	Water Bearing	Less than 50 gpm	Poor to Fair
		*Claggett Shale	2/Non-Water Bearing	2/ Less than 50 gpm	Poor to Fair
		Eagle Sandstone	Water Bearing	*** Less than 50 gpm	Fair to Good
	COLORADO GROUP	Telegraph Creek Formation	Water Bearing	Less than 50 gpm	Fair to Poor
		Niobrara Formation	Non-Water Bearing		
		*Cody Shale	Non-Water Bearing		
		*Carlile Shale	Non-Water Bearing		
		*Greenhorn Formation	Non-Water Bearing		
	LOWER	Frontier Formation	Non-Water Bearing		
		Frontier, Torchlight Member	Water Bearing	*** Less than 50 gpm	Poor
		Belle Fourche Shale	Non-Water Bearing		
		*Mowry Shale	Non-Water Bearing		
		Muddy Sandstone	Water Bearing	Less than 50 gpm	Poor
		*Thermopolis Shale	Non-Water Bearing		
		Cloverly Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
JURASSIC		Morrison Formation	Water Bearing	Less than 50 gpm	Poor to Fair
		Swift Formation	Water Bearing	Less than 50 gpm	Poor to Fair
		Rierdon Formation	Non-Water Bearing		
		Sundance Formation	Water Bearing	Less than 50 gpm	Poor
		*Gypsum Spring-Piper Formation	Non-Water Bearing		
TRIASSIC		*Chugwater Formation	Non-Water Bearing		
		*Dinwoody Formation	Non-Water Bearing		
PERMIAN		Phosphoria Formation	Water Bearing	Less than 50 gpm	Poor
PENNSYLVANIAN		Tensleep Sandstone	Water Bearing	*** 50 - 450 gpm	Fair to Good
		Amsden Formation	Water Bearing	*** 50 - 450 gpm	Fair to Good
MISSISSIPPIAN		Madison Group	Water Bearing	*** 50 - 450 gpm	Good
DEVONIAN		Jefferson Limestone	Water Bearing	*** Less than 50 gpm	Good
ORDOVICIAN		*Big Horn Dolomite	Non-Water Bearing		
CAMBRIAN		Gallatin Limestone	Water Bearing	*** Less than 50 gpm	Poor to Fair
		Gros Ventre Formation	Non-Water Bearing		
		*Flathead Quartzite	Water Bearing	*** 50 - 450 gpm	Good
PRECAMBRIAN		*Metamorphic & Igneous Rocks	Non-Water Bearing		

WYOMING PORTION

AGE		FORMATION NAME	WATER BEARING PROPERTIES	EXPECTED YIELDS	1/ USUAL QUALITY
QUATERNARY		Valley Alluvium	Water Bearing	** 50 - 450 gpm	Fair to Good
TERTIARY	Miocene	Miocene & Oligocene Rocks	Water Bearing Properties Unknown		
	Oligocene	*Intrusive Pyroclastics	Non-Water Bearing		
		Extrusive Pyroclastics	Non-Water Bearing		
	Eocene	Upper & Middle Eocene Rocks	Water Bearing	Less than 50 gpm	Good
		Wind River Formation	Water Bearing	Less than 50 gpm	Fair
		Wasatch Formation	Water Bearing	Less than 50 gpm	Fair
	Paleocene	Fort Union Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
CRETACEOUS	UPPER	Lance & Meeteetse Formation	Water Bearing	Less than 50 gpm	Fair
		Mesaverde Group	Water Bearing	*** Less than 50 gpm	Fair to Good
	COLORADO GROUP	*Cody Shale	Non-Water Bearing		
		Frontier Formation	Water Bearing	*** Less than 50 gpm	Poor
	LOWER	*Mowry & Thermopolis Shales	Non-Water Bearing		
		Cloverly & Morrison Formations	Water Bearing	*** Less than 50 gpm	Fair to Good
JURASSIC		Sundance Formation	Water Bearing	*** Less than 50 gpm	Poor
		*Gypsum Spring Formation	Non-Water Bearing		
TRIASSIC		Chugwater Formation	Non-Water Bearing		
		*Dinwoody Formation	Non-Water Bearing		
PERMIAN		Phosphoria Formation	Water Bearing	Less than 50 gpm	Poor
PENNSYLVANIAN		Tensleep Sandstone & Amsden Group	Water Bearing	50 - 450 gpm	Fair to Good
MISSISSIPPIAN		Madison Group	Water Bearing	Over 450 gpm	Good
DEVONIAN		Darby Formation	Water Bearing	Less than 50 gpm	Good
ORDOVICIAN		*Bighorn Dolomite	Non-Water Bearing		
CAMBRIAN		Gallatin Limestone	Water Bearing	Less than 50 gpm	Poor to Fair
		Gros Ventre Formation	Non-Water Bearing		
		*Flathead Quartzite	Water Bearing	Over 450 gpm	Good
PRECAMBRIAN		*Metamorphic & Igneous Rocks	Non-Water Bearing		

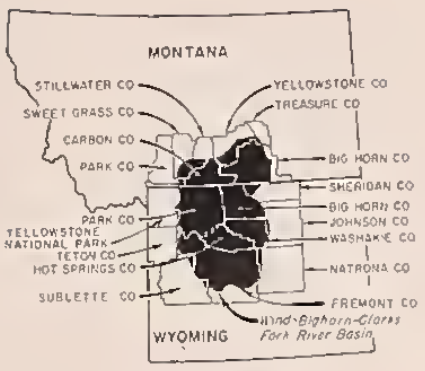
* These units may yield some water, but because of excessive mineralization, difficulty of drilling, massive structure, excessive depth in relation to yield and/or high elevation of outcrop areas, these formations are not normally considered aquifers.

** Larger yields may be obtained in local areas of thick, saturated deposits of high permeability, or by installing collector galleries or well-point systems in areas of thinner deposits.

*** These formations may contain confined water under artesian pressure, and wells penetrating a complete saturated section of these formations may produce more than the yield indicated here. Some areas may be tightly cemented and produce less than indicated here.

1/ Good - Usually suitable for most purposes.
Fair - Suitable for most purposes except domestic uses and irrigation of certain soils.
Poor - Excessivoly mineralized and not suitable for most uses.

2/ Parkman Sandstone member of Claggett may be water bearing.



LOCATION MAP

LEGEND

Quantity Generally Available Per Well

- Less than 50 gpm
- 50—450 gpm
- More than 450 gpm

Depth Within Which Ground Water May Be Expected

Alluvium

- Less than 100 Feet

Bedrock

- Less than 300 Feet
- 300—600 Feet
- 600—3,500 Feet
- Ground water not generally available

FIGURE 11-10

GENERAL AVAILABILITY OF GROUND WATER

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-SN-22441J

FIGURE II-11

AREAS COVERED BY GROUNDWATER REPORTS

WIND - BIGHORN - CLARKS FORK RIVER BASIN

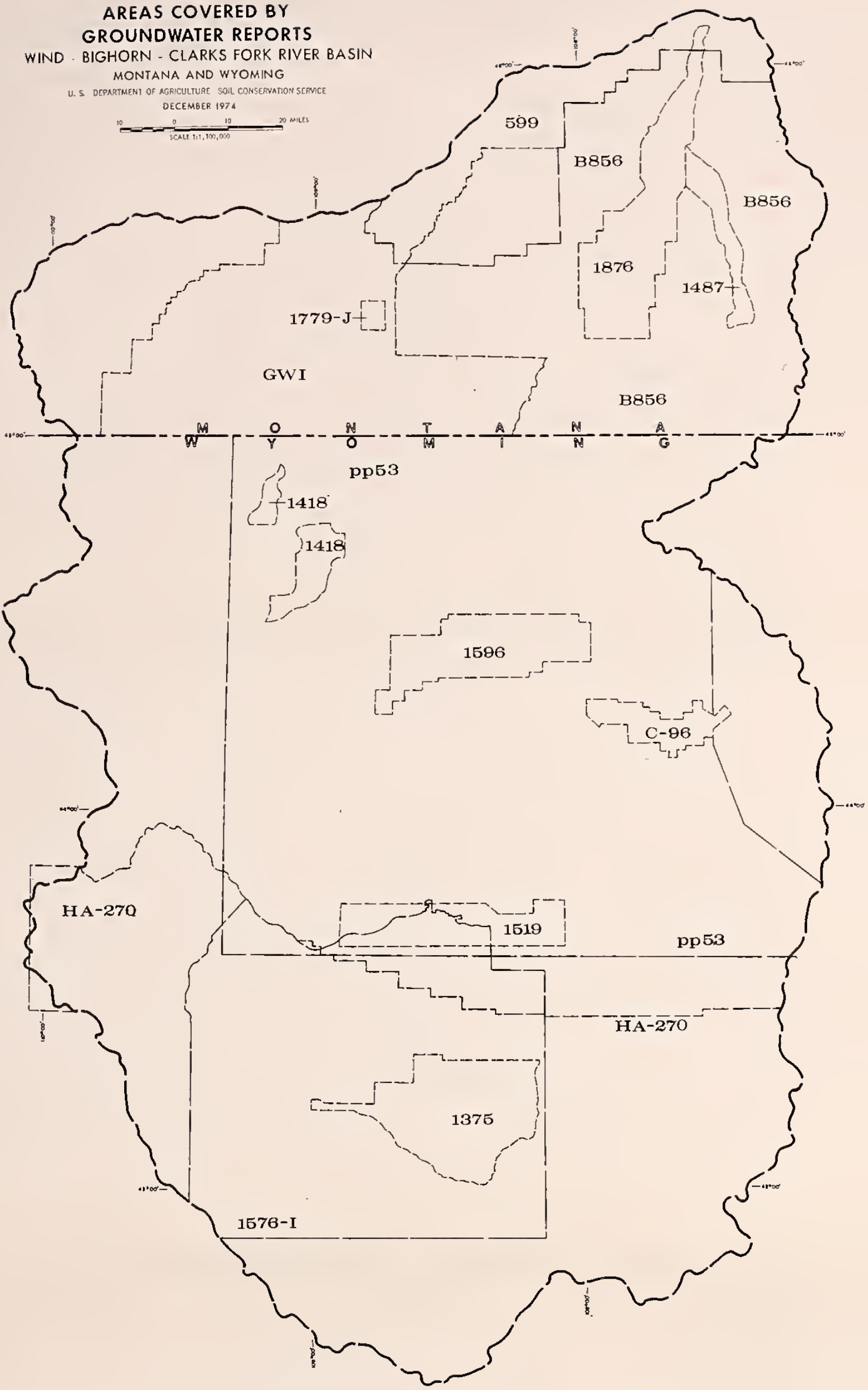
MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,100,000



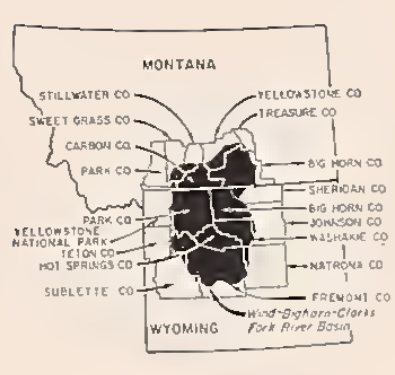
BIBLIOGRAPHY OF GROUND WATER AND RELATED STUDIES*

MONTANA

599	USGS Water Supply Paper 599, Ground Water in Yellowstone and Treasure Counties, Montana; G.M. Hall and C.S. Howard, 1929.
B856	USGS Bulletin 856. Geology of Big Horn County and the Crow Indian Reservation, Montana, 1935; W.T. Thom, Jr., G.M. Hall, C.H. Wegemann, and G.F. Moulton.
1487	USGS Water Supply Paper 1487, Geology and Ground Water Resources of the Lower Little Big Horn River Valley, Big Horn County, Montana; E.A. Moulder, M.F. Klug, D.A. Morris and F.A. Swenson, 1960.
1779-J	USGS Water Supply Paper 1779-J, Geology and Water Resources of the Bluewater Springs Area, Carbon County, Montana; E.A. Zimmerman, 1964.
1876	USGS Water Supply Paper 1876, Geology and Ground Water Resources of the Lower Big Horn Valley, Montana; L.J. Hamilton and Q.F. Paulson, 1968.
GWI	Ground Water Inventory, Carbon County, Montana, Montana Water Resources Board, 1969.

WYOMING

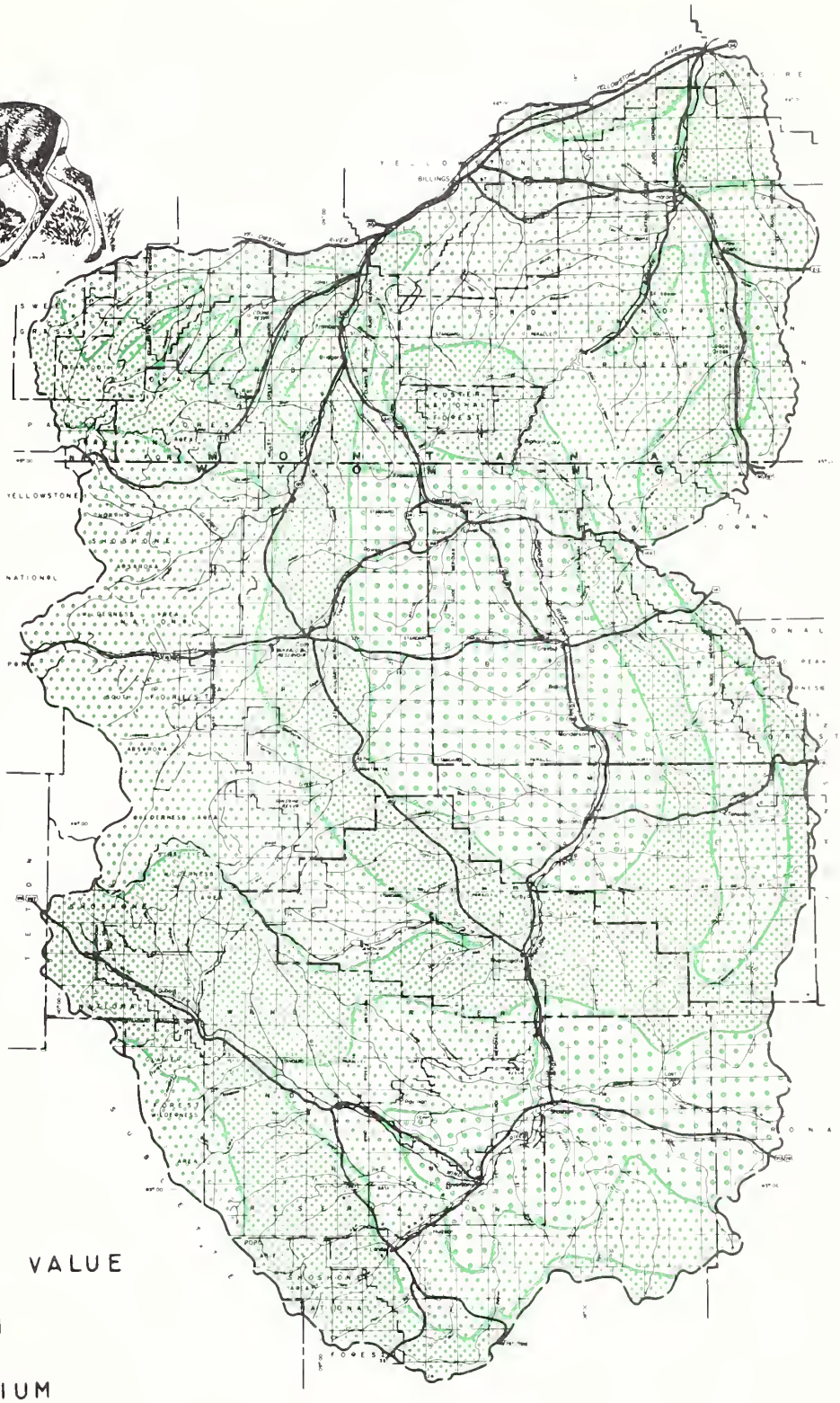
1596	USGS Water Supply Paper 1596, Geology and Ground Water Resources of the Greybull River - Dry Creek Area, Wyoming; C.J. Rabinove and R.H. Langford.
1519	USGS Water Supply Paper 1519, Geology and Ground Water Resources of the Owl Creek Area, Hot Springs County, Wyoming; D.W. Darry and R.T. Littleton.
1418	USGS Water Supply Paper 1418, Geology and Ground Water Heart Mountain and Chapman Bench Divistons, Shoshone Irrigation Project, Wyoming; H.A. Swenson.
1375	USGS Water Supply Paper 1375, Ground Water Resources of Riverton Irrigation Project Area, Wyoming: D.A. Morris, O.M. Hackett, K.E. Vanlier, and E.A. Moulder.
1576-I	USGS Water Supply Paper 1576-I, Ground Water Resources of the Wind River Indian Reservation, Wyoming; L.J. McGreavy, W.G. Hodson, and S.J. Rucker.
pp53	USGS Professional Paper 53, 1906; Geology and Water Resources of the Bighorn Basin, Wyoming; C.A. Fisher.
C-96	USGS Circular 96, Ground Water Resources of the Paintrock Irrigation Project, Wyoming; F.A. Swenson and W.K. Bach.
HA-270	U.S. Geological Hydrologic Atlas 270, Ground Water Resources and Geology of the Wind River Basin Area, Central Wyoming; H.A. Witcomb and M.E. Lowry.



LOCATION MAP

M7-EN-2244U-I





DEER HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study



FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

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ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study



ELK HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND OREG 1975

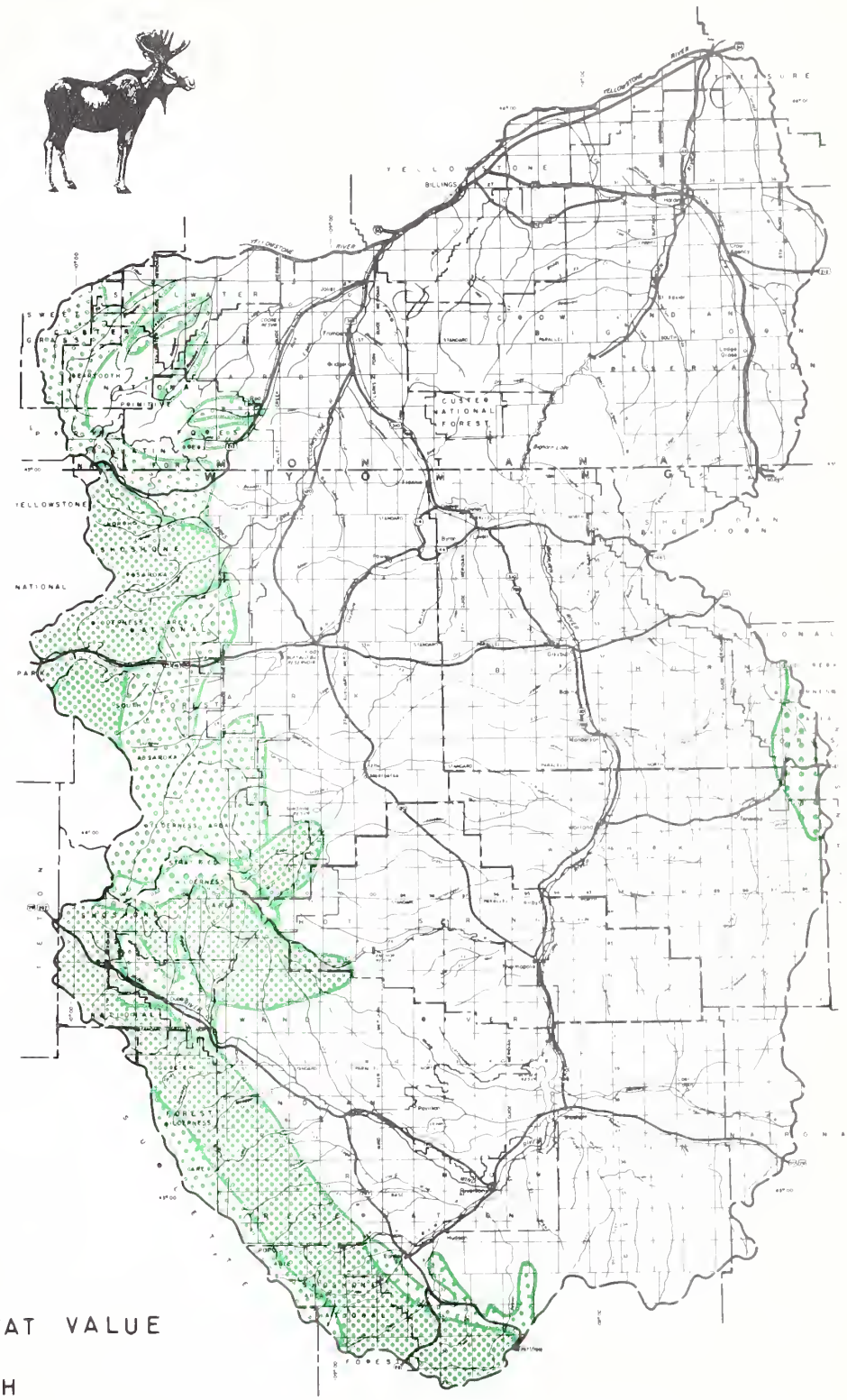


FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

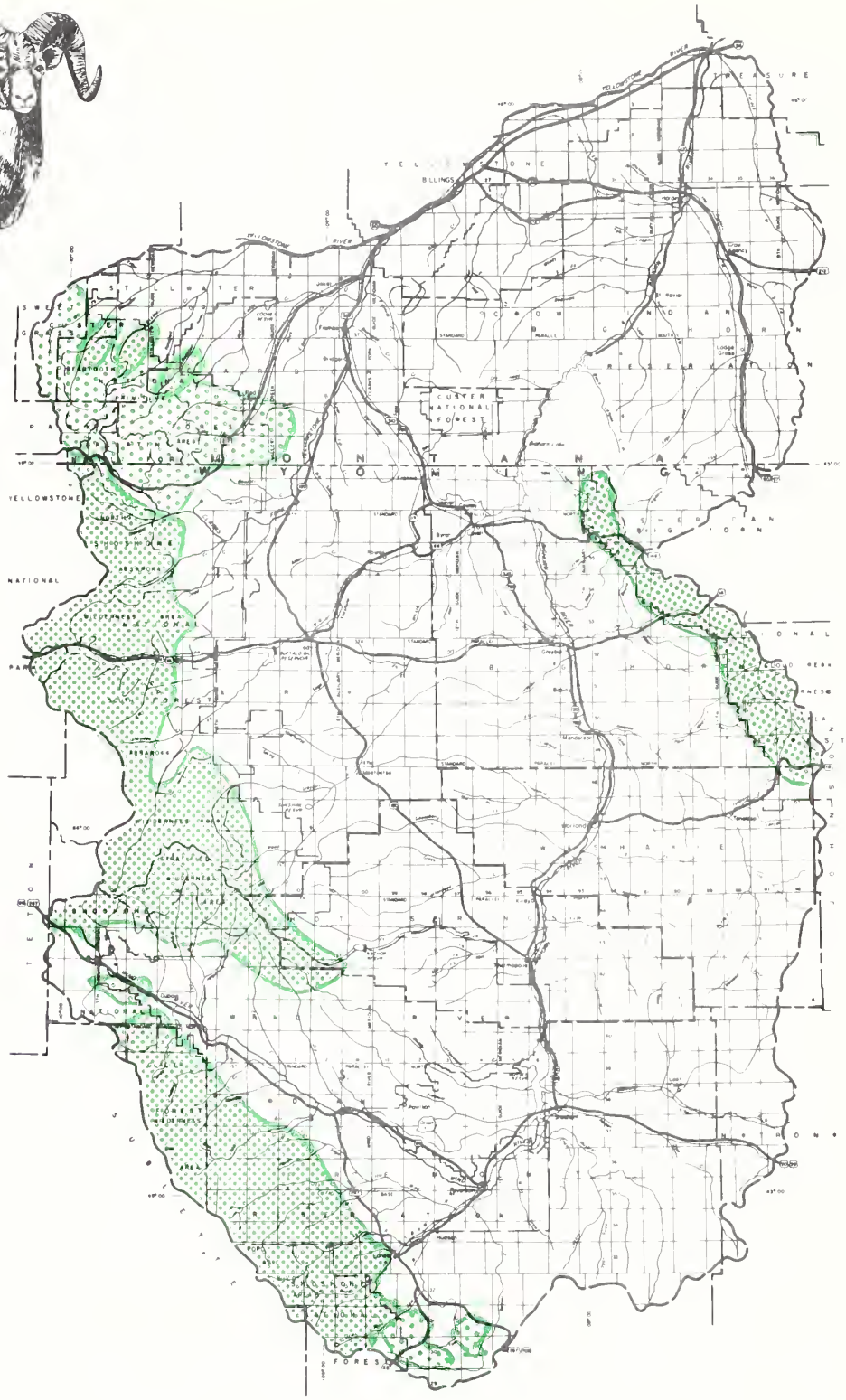
SCALE 1:2,100,000

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BIGHORN SHEEP
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

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MOUNTAIN GOAT
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

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Comprehensive Framework Study



BEAR HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

PLATE 5



Water resources of the basin depend on the melting of the high country snowpack. Much of the basin presently has abundant, good quality water. U.S. FOREST SERVICE PHOTO



In some locations, the Madison Flathead formations are capable of producing large flows. This is an artesian well with over 200 pounds per square inch of pressure.

This artesian well provides water for sprinkler irrigation.

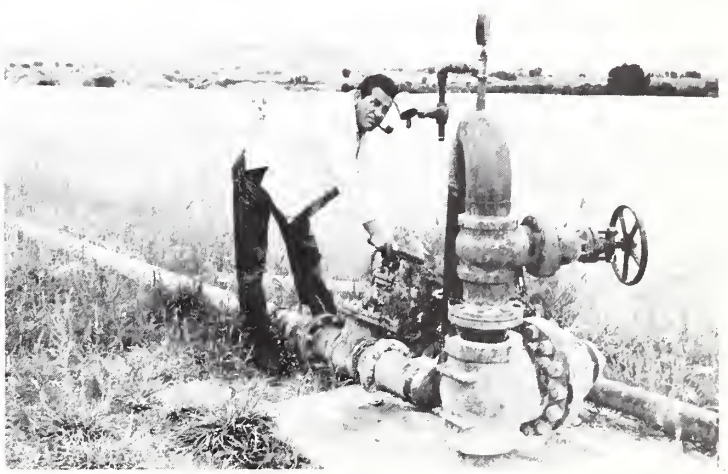


Table II-8--Big game species and their habitat[1/]

Common names	Area inhabited			Estimated population		
	Wyoming[2/]	Montana	Total	Wyoming	Montana	Total
	1,000 acres			numbers		
Elk	4,389[3/]	1,087	5,476	18,000	600	18,600
Deer	8,764[3/]	4,989	18,168	57,900	22,000	79,900
Moose	1,811	416	2,227	700	400	1,100
Antelope	8,742	3,524	12,266	13,100	5,000	18,100
Bear	4,191	908	5,099	900	500	1,400
Bighorn sheep	2,290	620	2,910	1,800[4/]	500	2,300[4/]
Mountain goat	100	96	196	NA[4/]	400	NA[4/]

1/ From data from state Game and Fish Commissions.
2/ Data do not include Indian trust lands or national park lands in Wyoming.
3/ Figure II-12 shows the entire basin (13,179,000 acres in Wyoming) as deer habitat. Indian trust lands, national park lands, alpine areas, badlands, towns, etc., are excluded from the 8,764,000 acres listed here.
4/ Data not available.

Upland and small game habitat

Various species of upland game can be found almost throughout the basin. Table II-9 lists species of upland game and their estimated area of habitat. Figure II-13 includes maps showing the location and general quality of habitat for pheasant, sage grouse, sharp-tailed grouse, mountain (blue and ruffed) grouse, hungarian partridge, merriam's turkey, and chukar partridge. Within these mapped areas is a wide range of quality habitat for each species. Short distance access to water and associated vegetation are general requirements for upland game. Private range and croplands provide important habitat areas for upland game.

Table II-9 --Habitat areas of upland game species

Common species name	Area inhabited	
	Wyoming	Montana
	1,000 acres	
Sage grouse	7,425	4,223
Sharp-tailed grouse	0	4,223
Blue and ruffed grouse	3,706	767
White-tailed ptarmigan	0	767
Ring-necked pheasant	803	7
Hungarian partridge (or gray partridge)	4,375	3,742
Chukar partridge	4,813	10
Bobwhite quail	5	0
Merriam's turkey	-	8
Cottontail rabbit	8,100	15

Waterfowl and wetland wildlife habitat

Waterfowl species found in the basin include canada geese, snow geese, mallards, and other ducks. Habitat for waterfowl and wetland wildlife ranges from the margins of high mountain lakes with restricted summer use to lands with impaired drainage in the lower portions of the basin. Irrigated croplands where grain crops are produced near small bodies of open water are particularly important to waterfowl. Figure II-14 shows major habitat areas and quality of habitat for ducks and geese. Stock ponds on rangelands are also very important waterfowl habitat.

There are no national wildlife management areas (refuges) in the basin. The Wyoming Game and Fish Commission owns 2,280 acres and administers 10,540 acres of federal lands near Riverton for wildlife. About 6,300 acres of this area is the surface of Ocean Lake. The Commission is also cooperating with agencies of the Department of Interior in developing a waterfowl management facility near Yellowtail Reservoir. About 1,000 acres of this area will have developed marshes with water control facilities.

Nongame birds

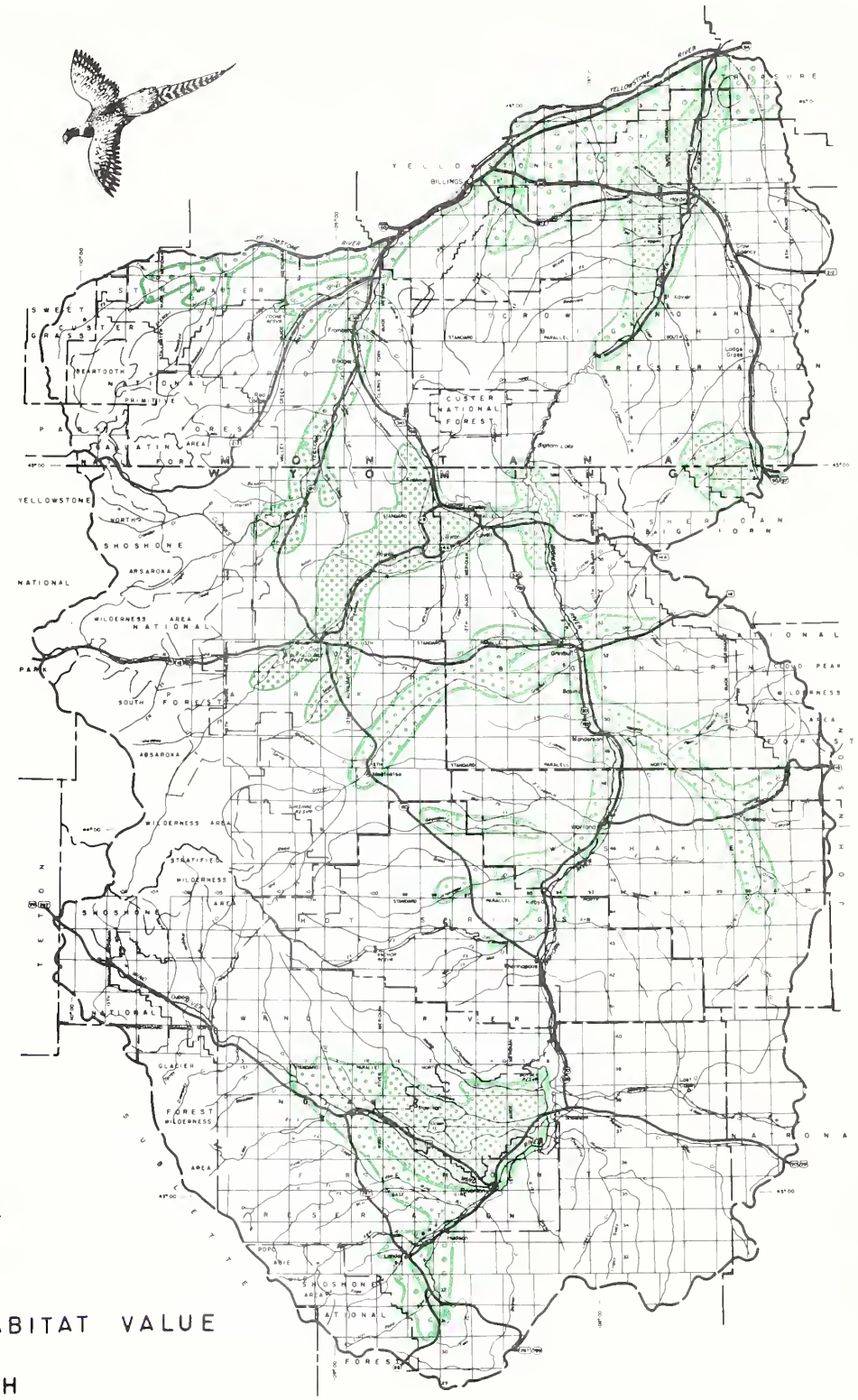
Many nongame species exist throughout the basin. Most of these birds are protected by federal or state law. Table II-10 is a list of commonly observed species in the basin as prepared by Dr. Oliver Scott in affiliation with the Murie Audubon Society, Casper, Wyoming.

Nongame mammals

Beaver, mink, muskrat, otter, marten, red fox, skunk, weasel, raccoon, jackrabbit, badger, coyote, bobcat, lynx, and limited numbers of fisher and wolverine are found in portions of the basin. The coyote has been subject to almost continuous control programs. The jackrabbit is hunted as a night sport when populations are high. Trapping is a minor industry in the basin. Landowners who incur damage, some hobby trappers, and a very few professional trappers do some trapping. Bobcats are hunted with dogs for sport or in predator control activities. On the southern flank of the Pryor Mountains is a wild horse range. This reserve is important, as it is one of the few formally recognized wild horse ranges in the country.

Fisheries

The streams in the basin have been mapped as shown in figure II-15 into five classifications based upon aesthetics, availability, and productivity. As shown on the map, class I represents fisheries of national importance. Class II includes fisheries of statewide importance, class III of regional importance, class IV of local importance, and class V streams are often incapable of supporting a fishery. Table II-11 lists miles of stream fishery by class.



PHEASANT HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE 11-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND OREG 1975



SAGE GROUSE
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

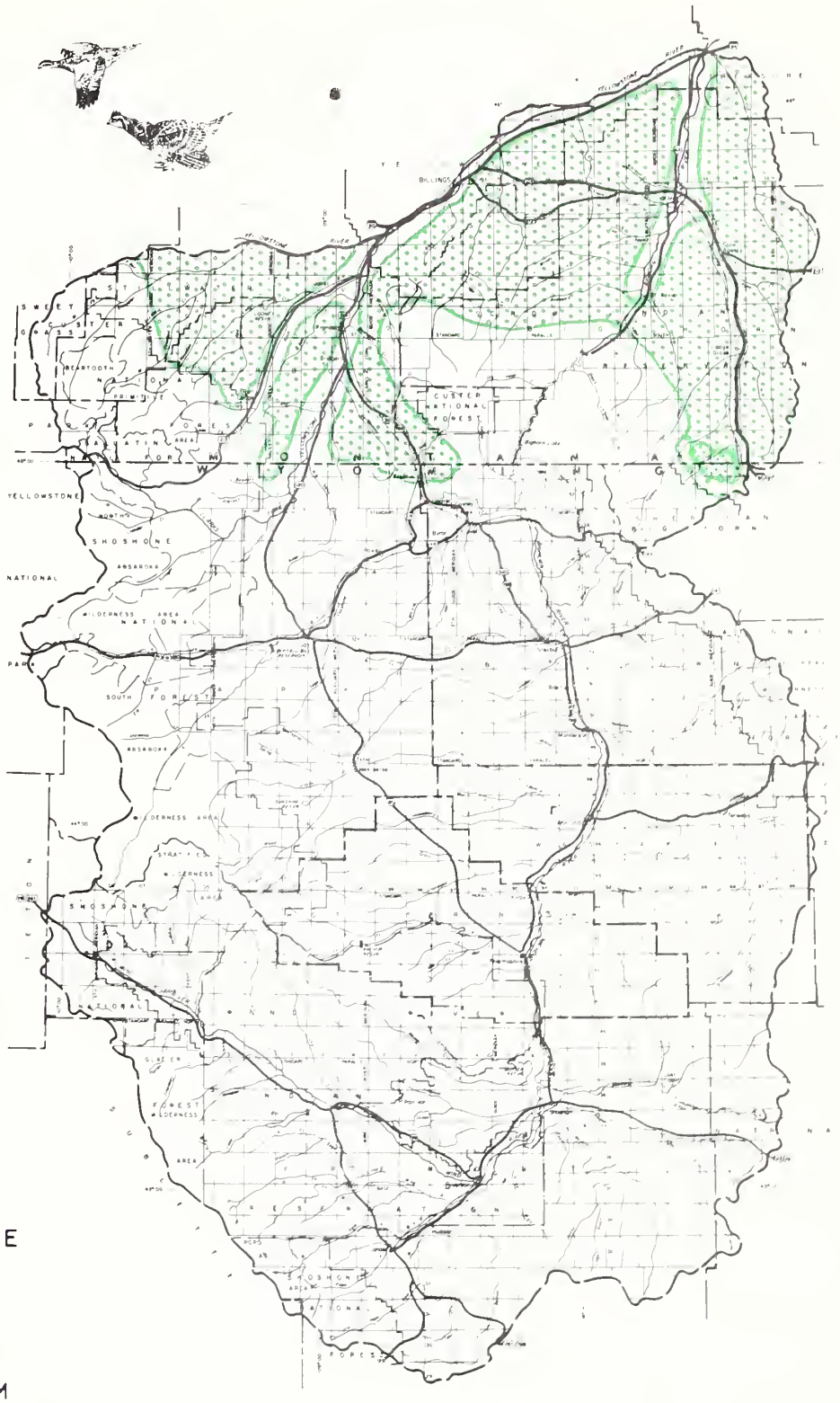
DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study



N

SHARPTAIL GROUSE
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

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Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG. 1975





MOUNTAIN GROUSE
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

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USDA SCS-PORTLAND, OREG. 1975



HUNGARIAN PARTRIDGE
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

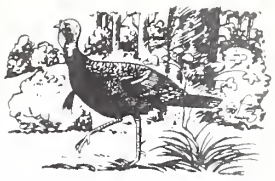
DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Fromework Study





TURKEY HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

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CHUKAR PARTRIDGE HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

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DUCK HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-14

WATERFOWL HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study



GOOSE HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-14

WATERFOWL HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

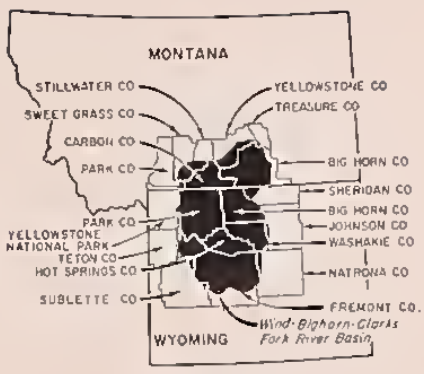
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

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USDA-SCS-PORTLAND GREG 1975



LOCATION MAP

STREAM FISHERY CLASSIFICATION

- Premium trout waters – fisheries of national importance
- Very good trout waters – fisheries of statewide importance
- Important trout waters – fisheries of regional importance
- Low production waters – fisheries frequently of local importance but generally incapable of sustaining substantial fishing pressure

FIGURE II-15

STREAM FISHERY CLASSIFICATION

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

Table II-10--Birds seen in the Wind-Bighorn-Clarks Fork River Basin

Name of Species	Code	Name of Species	Code	Name of Species	Code
Common Loon	(3m s)	Turkey Vulture	(2s)	Greater Yellowlegs	(3m)
Horned Grebe	(2m)	Goshawk	(3r)	Lesser Yellowlegs	(2m)
Eared Grebe	(2s)	Sharp-shinned Hawk	(3r)	Knot	(5m)
Western Grebe	(2s)	Cooper's Hawk	(3s)	Pectoral Sandpiper	(3m)
Pied-billed Grebe	(2s)	Red-tailed Hawk	(2r)	White-rumped Sandpiper	(4m)
White Pelican	(2m s)	Broad-winged Hawk	(5m)	Baird's Sandpiper	(2m)
Double-crested Cormorant	(2m s)	Swainson's Hawk	(2s)	Least Sandpiper	(2m)
Great Blue Heron	(2s)	Rough-legged Hawk	(2wv)	Dunlin	(4m)
Green Heron	(4m)	Ferruginous Hawk	(2s)	Long-billed Dowitcher	(2m)
Snowy Egret	(3m s)	Golden Eagle	(2r)	Stilt Sandpiper	(3m)
Black-crowned Night Heron	(2m s)	Bald Eagle	(2wv s)	Semipalmated Sandpiper	(3m)
American Bittern	(3s)	Marsh Hawk	(2r)	Western Sandpiper	(3m)
White-faced Ibis	(3m)	Osprey	(3m s)	Marbled Godwit	(3m)
Whistling Swan	(4m)	Prairie Falcon	(3r)	Hudsonian Godwit	(5m)
Canada Goose	(2r)	Peregrine Falcon	(4r)	Sanderling	(3m)
Snow Goose	(4m)	Pigeon Hawk	(4r)	Avocet	(2s)
Mallard	(2r)	Sparrow Hawk	(2s)	Black-necked Stilt	(4s)
Gadwall	(2s)	Sage Grouse	(2r)	Wilson's Phalarope	(1s)
Pintail	(2s)	Ring-necked Pheasant	(2r)	Northern Phalarope	(2m)
Green-winged Teal	(2s)	Chukar	(2r)	Herring Gull	(4m)
Blue-winged Teal	(2s)	Gray Partridge	(r)	California Gull	(2s)
Cinnamon Teal	(2s)	Sandhill Crane	(2s)	Ring-billed Gull	(2m)
American Widgeon	(2s)	Virginia Rail	(3s)	Franklin's Gull	(2m)
Shoveler	(2s)	Sora	(2s)	Bonaparte's Gull	(3m)
Redhead	(2s)	American Coot	(1s)	Sabine's Gull	(4m)
Ring-necked Duck	(3m)	Semipalmated Plover	(3m)	Forster's Tern	(2m)
Canvasback	(2m s)	Piping Plover	(4m)	Common Tern	(4m)
Greater Scaup Duck	(4m)	Snowy Plover	(5m)	Caspian Tern	(3s)
Lesser Scaup Duck	(2s)	Killdeer	(1s)	Black Tern	(2s)
Common Goldeneye	(2wv)	Mountain Plover	(3s)	Mourning Dove	(1s)
Barrow's Goldeneye	(2m s)	American Golden Plover	(5m)	Black-billed Cuckoo	(2s)
Bufflehead	(2m s)	Black-bellied Plover	(3m)	Screech Owl	(4s)
Oldsquaw	(5m)	Ruddy Turnstone	(4m)	Horned Owl	(2r)
Harlequin Duck	(3s)	Common Snipe	(2r)	Snowy Owl	(4wv)
White-winged Scoter	(4m)	Long-billed Curlew	(2s)	Burrowing Owl	(3s)
Surf Scoter	(4m)	Whimbrel	(3m)	Long-eared Owl	(3r)
Ruddy Ouck	(2s)	Upland Plover	(2s)	Short-eared Owl	(2r)
Hooded Merganser	(3m)	Spotted Sandpiper	(2s)	Saw-whet Owl	(4m)
Common Merganser	(2r)	Solitary Sandpiper	(2m)	Poor-will	(2s)
Red-breasted Merganser	(3m)	Willet	(2s)	Common Nighthawk	(2s)
White-throated Swift	(2s)	House Wren	(2s)	Red-winged Blackbird	(1s)
Broad-tailed Hummingbird	(2s)	Winter Wren	(4m)	Bullock's Oriole	(2s)
Rufous Hummingbird	(3m)	Long-billed Marsh Wren	(2s)	Rusty Blackbird	(4m)
Calliope Hummingbird	(2s)	Rock Wren	(1s)	Brewer's Blackbird	(2s)
Belted Kingfisher	(2r)	Mockingbird	(3r)	Common Grackle	(2s)
Yellow-shafted Flicker	(3r)	Catbird	(2s)	Brown-headed Cowbird	(2s)
Red-shafted Flicker	(2r)	Brown Thrasher	(2s)	Western Tanager	(2s)
Red-headed Woodpecker	(3s)	Sage Thrasher	(2s)	Black-headed Grosbeak	(2s)
Lewis' Woodpecker	(2s)	Robin	(1r)	Blue Grosbeak	(4s)
Yellow-bellied Sapsucker	(2s)	Hermit Thrush	(3s Mts)	Indigo Bunting	(4s)
Hairy Woodpecker	(2r)	Swainson's Thrush	(2s Mts)	Lazuli Bunting	(2s)
Downy Woodpecker	(2r)	Veery	(2s)	Evening Grosbeak	(2wv)
Eastern Kingbird	(2s)	Mountain Bluebird	(2s)	Caccin's Finch	(2r)
Western Kingbird	(2s)	Townsend's Solitaire	(2r Mts)	House Finch	(2r)
Say's Phoebe	(2s)	Golden-crowned Kinglet	(2s Mts)	Pine Grosbeak	(3r Mts)
		Ruby-crowned Kinglet	(2s Mts)		
Traill's Flycatcher	(2s Mts)	Water Pipit	(2s A)	Gray-crowned Rosy Finch	(2wv 2s)
Least Flycatcher	(2s)	Bohemian Waxwing	(2wv)	Black Rosy Finch	(2s Mts)
Dusky Flycatcher	(2s)	Cedar Waxwing	(2s)	Common Redpoll	(2wv)
Western Flycatcher	(2s)	Northern Shrike	(2wv)	Pine Siskin	(2s)
Western Wood Pewee	(1s)	Loggerhead Shrike	(2s)	American Goldfinch	(2s)
Olive-sided Flycatcher	(3s Mts)	Starling	(2r)	Red Crossbill	(2r Mts)
Horned Lark	(1r)	Solitary Vireo	(3s)	White-winged Crossbill	(4m)
Violet-green Swallow	(2s)	Red-eyed Vireo	(2s)	Green-tailed Towhee	(2s Mts)
Tree Swallow	(2s)	Warbling Vireo	(1s)	Rufous-sided Towhee	(2s)
Bank Swallow	(3s)	Tennessee Warbler	(4m)	Lark Bunting	(1s)
Rough-winged Swallow	(2s)	Orange-crowned Warbler	(2s)	Savannah Sparrow	(2s)
				Grasshopper Sparrow	(2s)
Barn Swallow	(3s)	Nashville Warbler	(4m)	Vesper Sparrow	(1s)
Cliff Swallow	(1s)	Yellow Warbler	(1s)	Lark Sparrow	(2s)
Purple Martin	(4s)	Myrtle Warbler	(2m)	Slate-colored Junco	(3wv)
Gray Jay	(2r Mts)	Audubon's Warbler	(2s)	Oregon Junco	(2r)
Steller's Jay	(2r Mts)	Black-throated Gray Warbler	(2s)	Gray-headed Junco	(2s Mts)
Black-billed Magpie	(1r)	Townsend's Warbler	(3m)	Tree Sparrow	(2wv)
Common Raven	(2r Mts)	Blackpoll Warbler	(4m)	Chipping Sparrow	(2s Mts)
Common Crow	(2r)	Northern Waterthrush	(3m)	Brewer's Sparrow	(2s)
Pinon Jay	(2r)	MacGillivray's Warbler	(2s Mts)	Harris' Sparrow	(3wv)
Clark's Nutcracker	(2r Mts)	Yellowthroat	(2s)	White-crowned Sparrow	(2s Mts)
Black-capped Chickadee	(2r)	Yellow-breasted Chat	(2s)	White-throated Sparrow	(3m)
Mountain Chickadee	(2r)	Wilson's Warbler	(2s Mts)	Fox Sparrow	(2s 3wv)
White-breasted Nuthatch	(2r)	American Redstart	(3s)	Lincoln's Sparrow	(2s Mts)
Red-breasted Nuthatch	(2r)	House Sparrow	(1r)	Song Sparrow	(2r)
Pygmy Nuthatch	(3ri)	Bobolink	(3s)	McCown's Longspur	(2s)
Brown Creeper	(2r)	Western Meadowlark	(1s)	Lapland Longspur	(3m)
Water Ouzel	(2s Mts)	Yellow-headed Blackbird	(2s)	Snow Bunting	(3wv)

KEY TO CODE

1 - abundant
2 - common
3 - uncommon
4 - rare
5 - casual

m - migrant
s - summer resident
r - resident
wv - winter visitant
f - formerly
i - irregular

Mts - mountains
A - alpine zone

Lakes, reservoirs, and ponds were not classified as were the streams, but are listed by seven types in table II-12. Low elevation, man-made lakes and reservoirs are very important fisheries if judged by fisherman use. They support most of the fishing pressure in the basin. Lakes, ponds, and reservoirs provide nearly four times as many fisherman-days as do the streams.

Table II-11--Summary of stream miles by fishery class

State	I	II	III	IV	V	Total classified
	miles					
Wyoming	3	449	2,435	1,286	81	4,254
Montana	0	179	48	269	0	496
Total	3	628	2,483	1,555	81	4,750

Table II-12--Number of lakes, ponds, and reservoirs with fish

State	Natural alpine lakes	Alpine reservoirs	Lowland lakes	Lowland reservoirs	Farm ponds: Cold water species	Farm ponds: Mixed species	Farm ponds: Warm water species	Total
	number							
Wyoming	741	25	30	75	126	5	42	1,044
Montana	122	2	6	3	81	0	3	217
Total	863	27	36	78	207	5	45	1,261

The most common trout include rainbow, brown, brook, golden, and cutthroat. Brook trout and native cutthroat trout are more common in the high mountain lakes and streams. Other important game fish include ling, grayling, walleye pike, bass, and crappie. Nongame species such as carp are being studied for commercial fish production in Ocean Lake. Several other nongame species are found in the basin.

Threatened species

Mammal and bird species which may be found in the basin that are classed as threatened, or for which status is undetermined, are listed below:



Bighorn sheep are native to the Bighorn Basin.

U.S. FOREST SERVICE PHOTO

Big game are plentiful in the basin.





There is a wide variety of game birds in the basin.



Grizzly Peak ski area provides about 65,000 skier days per year to people of all ages and skills. USDA-FOREST SERVICE PHOTO



PLATE 8

Status	Class	Species
Threatened	Mammal	Spotted bat
		Grizzly bear
		Black-footed ferret
	Bird	Prairie falcon
		American peregrine falcon
Status Undetermined	Mammal	Pine marten
		Fisher
		Wolverine
		Canada lynx
	Bird	Ferruginous hawk
		American osprey

Compiled from:
Threatened Wildlife of the United States, USDI, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, 1973

RECREATIONAL FEATURES

Outstanding natural and scenic resources offer great opportunities for outdoor recreation in the basin. The mountains are the principal area of recreational activity because of their scenery, forests, lakes, streams, wildlife, and cool summer climate. The mountains contain several wilderness and primitive areas and a small part of Yellowstone National Park. Scattered glacial lakes and mountain streams provide spectacular scenery and cold water fishing. Numerous forest campsites are provided in the national forests.

In the lower areas of the basin are scenic desert formations, larger rivers, lakes, and reservoirs. Irrigated croplands add greenery to the desert landscape. Recreational facilities are also provided by the private sector. Dude ranches, lodges, ski resorts, outfitting, packing, hunting trips, fishing trips, summer cottages, campgrounds, and other services are available.

Public access is provided at the larger reservoirs such as Boysen, Buffalo Bill, and Bighorn Lake. These lakes are popular recreation areas. Bighorn Lake is particularly scenic. Major highways and other roads provide access to some of the mountain areas. Public fishing and hunting access areas are available at several locations along important fishing streams. State parks at Boysen, Buffalo Bill, and Thermopolis Hot Springs provide picnic, camping, or swimming facilities. The Buffalo Bill Museum at Cody is one of the most popular recreational facilities in the basin. Archeological sites such as the Medicine Wheel, east of Lovell in the Bighorn Mountains, also attract many visitors. The Custer Battlefield National Monument is an important historical site. The site of

Fort C. F. Smith and Chief Plenty Coups Memorial State Monument are other important historical sites. The Beartooth Highway, from Red Lodge to Yellowstone National Park, winds to elevations of 11,000 feet. The fact that alpine vegetation and spectacular scenery may be viewed from a passenger car (a relatively rare opportunity) is reason to consider designating this as a National Scenic Highway.

Part of the scenic desert badlands area north of Gooseberry Creek and west of Worland could be designated as a National Monument.

The Pryor Mountains provide a unique opportunity for the student of archeology, history, or wild horses. This area was inhabited as much as 9,000 years ago. Chief Joseph and his tribe traveled this way in 1877 when pursued by the U. S. Army. This area is being studied for its archeological value and need for preservation.

QUALITY OF THE NATURAL ENVIRONMENT

General

The low population density of less than three persons per square mile has tended to preserve much of the quality of the environment in a seminative state. However, the environment has been altered, to varying degrees, by activities of man. Past grazing by livestock and wildlife has been excessive for the resource in some areas and caused an increase in the amount of big sagebrush. It is generally considered that pure stands of big sagebrush do not provide quality watersheds. About three-fourths of a million acres of irrigated cropland have been developed along mountain streams and on desert benches. Inefficient irrigation practices which result in large amounts of waste water have caused erosion of small streams and waterways and deposited sediment into the larger rivers and man-made lakes.

These irrigation diversions also affect fish habitat by reducing natural streamflows. Conversely, irrigated lands have encouraged increased numbers of some species of wildlife and allowed introduction of some exotic species such as the pheasant.

Recreational use by hunters, fishermen, and tourists have affected environmental quality in more remote regions. Mining and oil field development have affected landscapes and streams.

Forests are very important components of the natural environment. Forested lands are quite stable and, unless disturbed, have low rates of erosion and sediment production.

Water quality

In the planning of the use of water resources, consideration must be given to water quality. Every water use has definite water quality requirements. Whenever water quality deteriorates below the minimum



Outfitting and packing are important activities.

USDA - FOREST SERVICE PHOTO



Fishing in a mountain lake can be a unique recreation experience. USDA - FOREST SERVICE PHOTO



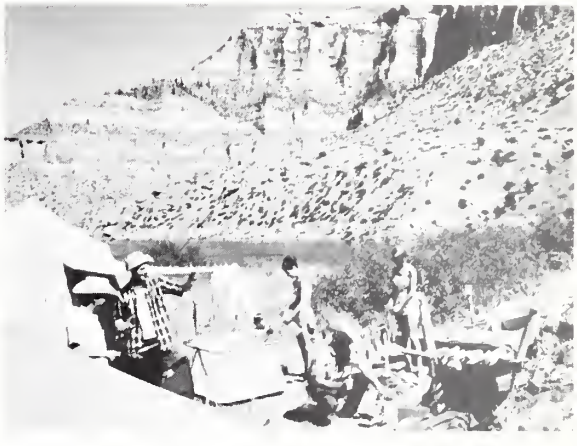
The Buffalo Bill Museum at Cody is one of the most popular tourist stops in the basin.



From Rock Creek valley to the alpine tundra over the switchbacks of the Beartooth Highway USDA - FOREST SERVICE PHOTO



An alpine lake on the Beartooth plateau. USDA-FOREST SERVICE PHOTO



Big Bull Elk Canyon camp in Bighorn National Recreation area.

BUREAU OF RECLAMATION PHOTO

PLATE 10

requirement of any use, the use is lost or made more expensive by the need for water treatment. The aim of water quality programs is to maintain or improve water quality so that multiple water uses can be maintained.

The quality of most of the waters of this river basin can be described as good. Excellent quality is found in the high mountains where most of the basin's water originates. Remoteness and lack of developed access have protected water quality in these mountainous forest watersheds. However, there is a gradual decline in quality as the water moves downstream. This decrease in quality is largely the result of natural conditions. Runoff from lower elevation lands carries much higher concentrations of minerals, sediments, and other pollutants than runoff from the mountain watersheds.

While there are places on the streams, notably near towns and a few feedlots where biologic pollutants are discharged into streams, we have no record of significant adverse effects at present. Dissolved oxygen levels are apparently satisfactory at all locations where sampling is conducted on a regular basis. The major pollutants of water in the basin are suspended sediments and dissolved solids. Table II-13 is a list of the average annual concentration of dissolved solids at locations where these data are measured and published by the U. S. Geological Survey.

The recommended maximum concentration of total dissolved solids in private or semipublic water supplies is 1,000 milligrams per liter (mg/l) when no other water is available, and for livestock up to 2,500 mg/l is acceptable.

Concentrations of dissolved solids (TDS) and suspended sediments vary greatly during the year. For example, in water year 1966, TDS in the Little Wind River near Riverton varied from 290 mg/l on May 15 to 842 on August 20 and 874 on March 18. The suspended sediment in Fivemile Creek near Shoshoni in the same year varied from 180 mg/l on November 7 to 3,900 mg/l on April 16. Badwater Creek at Lysite varied from 68 mg/l on January 7 to 38,000 mg/l on June 23. Suspended sediment loads are not widely measured in the basin and are not listed for that reason.

Reservoirs affect the concentration of TDS adversely. Evaporation from the reservoir causes increased concentrations. They generally have a significant beneficial effect in reducing concentrations of suspended sediments. This effect is important to the class I blue ribbon trout stream fishery 3 miles downstream from Boysen Reservoir, for example.

Irrigation return flows are important contributors of suspended sediment and TDS loads to the lower streams of the basin. Much of the increase of TDS in the Shoshone River from Lovell to Kane is the result of irrigation return flows.

Natural mineralized hot springs are also important contributors of dissolved solids. Much of the increase in TDS in the Bighorn River from Boysen to Lucerne comes from Thermopolis Hot Springs. These are claimed

Table II-13--Average annual concentration of total dissolved solids

Gaging location	Total dissolved solids
	mg/l
Wind River near Dubois	105
Wind River at Riverton	205
Little Wind River near Riverton	390
Fivemile Creek near Shoshoni	1,240
Wind River below Boysen	460
Bighorn River at Lucerne	520
Bighorn River at Neiber	555
Bighorn River at Worland	600
Nowood River at Manderson	470
Greybull River near Basin	625
Shell Creek near Greybull	645
Bighorn River at Kane	620
Shoshone River below Buffalo Bill Reservoir	225
Shoshone River near Lovell	465
Shoshone River at Kane	695
Little Bighorn River near Hardin	478
Bighorn River near Bighorn	699
Clarks Fork River near Chance	107
Clarks Fork near Laurel	434

Compiled from:
Water resource records for Wyoming and Montana, part 2, water quality records, U.S. Geological Survey. Data furnished by Wyoming Water Planning Program.

to be the largest such springs in the world. Hot springs on the Shoshone River below Buffalo Bill Dam are quite mineralized. Saline waters from oil wells also contribute dissolved solids to the stream system of the basin. The Hamilton Dome and Elk Basin oil fields have a significant problem in this respect.

III. ECONOMIC DEVELOPMENT

HISTORICAL DEVELOPMENT

Archeologists have discovered evidence that man inhabited portions of the basin as long as 9,000 years ago. Some important evidence of early activity is still visible on the surface. The Medicine Wheel is an early relic of unknown origin and purpose. From its place on a high promontory of the northern Bighorn Mountains one commands a tremendous view of the Bighorn Basin. The wheel is formed of stones laid side by side in a circle 78 feet in diameter. Six rock cairns 2½ feet high are around the rim of the wheel. Five cairns face inward toward the center of the wheel. The sixth faces outward, toward the rising sun. This site may be reached by automobile and is a popular tourist stop. Near Meeteetse, on the banks of the Greybull River, is a 30 foot long arrow, also formed by laying rocks side by side, which points toward the Medicine Wheel. The original purpose of these archeological ruins is not known.

Excavations in Mummy Cave near Cody indicate occupation as early as 7280 B.C. Mummy Joe, for whom the cave is named, was wrapped in a sheepskin garment. A salvaged piece places his burial in the year 734 A.D. All of the cultural layers give evidence that young mountain sheep were the principal food supply for the cave dwellers.

Indian tribes active in the basin in recent times included the Sioux, Crow, Cheyenne, Arapahoe, Shoshone, and Sheepeaters. They ranged along the foothills, using the basin for hunting grounds during the summer and fall. The Shoshones occasionally wintered near the Wind River Basin, but the Sheepeaters were probably the only tribe in permanent residence.

The first recorded entry of white man occurred in 1743 when Chevalier de La Verendrye passed through in search of a route to the Pacific Ocean. Others came in 1804 in search of furs and gold. The Lewis and Clark expedition came down the Yellowstone River in 1806. The next year John Colter was sent out alone from the Manuel Liza expedition to promote fur trade with the Indians. He went up the Shoshone River to above Cody and described the geyser activity at the mouth of the canyon there. He went north to Sunlight Creek, east and south to the west slope of the Bighorn Mountains near Thermopolis, and went south to the Riverton-Lander area. From there he traveled northwest up the Wind River, over Togwotee Pass, and into the Jackson Hole and Yellowstone Park area.

Ashley's fur traders came down the Wind River in 1827. Captain L. E. Bonneville's rendezvous of 1833 was on the Popo Agie River, and Nathaniel Wyeth came through the area the same year. In 1860 Jim Bridger led a war department expedition through the basin to Yellowstone Park. In 1864 Jim Bridger and John Bozeman blazed the Bozeman Trail from Fort Fetterman on the Platte River to Three Forks on the Missouri River. This trail crossed the Bighorn River at Fort C. F. Smith.

The gold diggings at South Pass and Atlantic City provided the State of Wyoming with its first population center away from the Union Pacific Railroad. This expansion spilled over into the Wind River Basin. In 1868 settlers formally set forth the boundaries of Fremont County and ordered the town of Lander to be laid out. This was the year of government treaties with the Crow Indians at Fort Laramie and the Shoshone Indians in the Green River area. The Shoshone were moved to the site of the present Wind River Indian Reservation. This upset the local settlers, and their action seems to have been more to assert state's rights than to organize local government.

These and other incursions, settlements, mining developments, and military actions were violently resented by the Indian tribes, particularly the Sioux, Crow, and Northern Cheyenne. The Sioux moved north, Custer's troops moved west, and the stage was set for the crushing climax. The fight between the Sioux tribes and Custer's troops near the present site of Crow Agency on the Little Bighorn River occurred June 25 and 26, 1876. Custer's troops were massacred, but this brought massive retaliation by the government. In 1877 Fort Custer was established near Hardin. Also, in 1877 Chief Joseph and his Nez Perce made their famous retreat over the mountains and down the Clarks Fork River before they were captured in northern Montana. The Northern Pacific Railroad was built along the Yellowstone River, and coal mines were opened near Red Lodge to fuel the locomotives.

Development from 1877 to 1890 was fairly slow, but in 1892 most of the western portion of the Crow Indian Reservation was opened for settlement. In 1894 the Carey Act was passed, allowing the development of public lands by the construction of irrigation works. Mormon colonies started moving into the Bighorn Basin. The Bridger Trail, an alternate to the Bozeman Trail, traversed the basin from south to north, and stagecoach routes were developed over the Bighorn Mountains from Buffalo and Sheridan. The Burlington Railroad was extended south from Toluca, Montana, in 1905. By 1908 Thermopolis had railroad service. The Wyoming and Northwestern Railroad Company built west from Casper to Shoshoni in 1906 and from Shoshoni to Lander in 1907. Surveyors from the Chicago and Northwestern Company surveyed a line through the Wind River Canyon that year, but work stopped at that point until 1913. In 1913 the Burlington Railroad purchased and used the earlier surveys, built through the canyon, and the basin had through train service.

The population explosion from 1900 to 1910 more than doubled the basin's population. Private irrigation companies assisted the settlement by developing the irrigation of more than 300,000 acres of land. Most of the present cities were founded, the present system of counties formed, and the location of most roads established by 1910.

Buffalo Bill Reservoir was completed by the Bureau of Reclamation in 1909, and federal reclamation projects were begun in the basin. A portion of the Riverton Reclamation Project was opened for settlement in 1926. More land was opened in the 1930's, but further development



An old tepee ring near the present Boysen Reservoir. Man inhabited portions of the basin as long as 9000 years ago.



The search for gold brought the first settlers into and around the basin.

was postponed until after World War II. Additional land was settled in 1947, 1949, and 1950. Trouble developed in repayments, and some of this land was returned to public ownership for a time. This land has since been auctioned to private ownership again. Boysen Reservoir was completed in 1951. Yellowtail Dam near Fort Smith was completed in 1965. About 30 percent of the irrigated land in the basin is served by these and other smaller reclamation projects.

GENERAL DESCRIPTION

Numerous factors have influenced the economic development of the Wind-Bighorn-Clarks Fork Basin. Population, employment, and income are the more important economic indicators of the area as it exists currently. These elements are described historically, measured in terms of present status, and projected to 1980, 2000, and 2020. Other economic and social factors such as migration, ethnic groups, education, labor force, etc., are only described and shown historically.

In order to present an overview of economic activity and social characteristics for the area, published materials were utilized extensively. Data from secondary sources are generally not available for areas smaller than a single county or a group of counties. Therefore, five counties in Wyoming and three counties in Montana are considered to be representative of the basin and are used as the geographic unit for economic study. The five Wyoming counties are Big Horn, Fremont, Hot Springs, Park, and Washakie. Montana counties are Big Horn, Carbon, and Stillwater.

Population

Total population of the study area declined from 1920 to 1930; increased for the next three decades; and then decreased from 1960 to 1970. The 1970 population count was 90,176 following a high of 94,038 in 1960. Population has been declining in the Montana portion of the basin; however, population increases in the Wyoming portion more than offset the losses from 1930 to 1960, table III-1.

Although basin residents are predominantly rural, they are becoming more urban-oriented. This trend toward urbanization reflects a migration from rural agricultural sectors and is characteristic of most sections of the United States. In 1970 nearly 40 percent of the population lived in urban areas (towns over 2,500) as compared to 17 percent in 1940, table III-2. Urban areas listed in descending order along with their 1970 population are as follows: Riverton (7,995), Lander (7,125), Cody (5,161), Worland (5,055), Powell (4,807), Thermopolis (3,063) in Wyoming and Hardin in Montana (2,733). None of these are large enough to be classed as a Standard Metropolitan Statistical Area.

The study area contained 31 incorporated communities in 1970 varying in size from 25 persons in Lost Cabin, Wyoming, and 31 people in Bearcreek, Montana, to the urban areas listed above. In table III-3 incorporated places

Table III-1--Total population of Wind-Bighorn-Clarks Fork study area

Area	1920	1930	1940	1950	1960	1970
	number					
Wyoming portion	39,493	39,504	50,447	60,440	70,188	68,407
Montana portion	29,924	27,367	27,978	25,481	23,850	21,769
Total	69,417	66,871	78,425	85,921	94,038	90,176

Source: U. S. Census of Population

Table III-2--Population by rural and urban categories, Wind-Bighorn-Clarks Fork study area

Category/Area	1940	1950	1960	1970
	number			
Urban:				
Wyoming portion	10,380	24,747	30,366	33,206
Montana portion	2,950	2,730	2,789	2,733
Urban subtotal	13,330	27,477	33,155	35,939
Rural farm:				
Wyoming portion	22,283	18,759	14,032	10,612
Montana portion	14,496	11,273	8,149	6,458
Rural farm subtotal	36,779	30,032	22,181	17,070
Rural non-farm:				
Wyoming portion	17,784	16,934	25,790	24,589
Montana portion	10,532	11,478	12,912	12,578
Rural non-farm subtotal	28,316	28,412	38,702	37,167
Total	78,425	85,921	94,038	90,176

Source: U.S. Census of Population

are listed according to their size class in 1970, thus revealing what changes have occurred since 1940. The rural orientation of this area is also disclosed by population density. There are about 2.8 persons per square mile in the eight-county area as compared to 3.4, 4.7, and 57.0 persons per square mile for Wyoming, Montana, and the United States, respectively.

The basin contains most of two Indian reservations--the Wind River in Wyoming and the Crow in Montana. In 1970, 9 percent of the total population



Those who found no gold began to settle the land. The sod-covered log house was the standard homesteader's residence.



This picture of a tar paper shack and serious wind erosion was taken in 1937 during the settlement of the Riverton Project.



In 1943 the tar paper shack remained, but a planted wind-break had helped heal the land.

PLATE 12



When repayment problems developed on a portion of the Riverton Reclamation Project, the land was purchased by the government; and some settlers abandoned their homes.



An "average" farmstead on an irrigated farm on the Riverton Reclamation Project. The windbreak of planted trees protects homes and reduces erosion.

Table III-3--Population of towns by size class,
Wind-Bighorn-Clarks Fork study area

Size class/area 1/	Towns	1940	1950	1960	1970
			number		
Less than 500:					
Wyoming portion	12	2,485	2,683	3,132	2,888
Montana portion	3	1,333	1,014	880	807
Subtotal	15	3,818	3,697	4,012	3,695
500-999:					
Wyoming portion	2	638	1,170	1,340	1,460
Montana portion	2	1,622	1,390	1,511	1,523
Subtotal	4	2,260	2,560	2,851	2,983
1,000-2,499:					
Wyoming portion	3	5,102	5,990	6,056	5,469
Montana portion	2	3,912	3,827	3,559	3,017
Subtotal	5	9,014	9,817	9,615	8,486
2,500-5,000:					
Wyoming portion	2	4,370	6,674	8,695	7,870
Montana portion	1	1,886	2,306	2,789	2,733
Subtotal	3	6,256	8,980	11,484	10,603
Over 5,000					
Wyoming portion	4	10,380	15,565	21,671	25,336
Montana portion	0	--	--	--	--
Subtotal	4	10,380	15,565	21,671	25,336
Total	31	31,728	40,619	49,633	51,103
Wyoming portion	23	22,975	32,082	40,894	43,023
Montana portion	8	8,753	8,537	8,739	8,080

Source: U. S. Census of Population
1/ Population of towns in 1970 determined size class for all years shown above.

and 13 percent of all rural inhabitants were Indians. The number of Indians increased from 6,972 in 1960 to 8,013 in 1970. Over 90 percent live in rural areas.

From 1960 to 1970, migration patterns have influenced population changes in the study area by a greater amount than births and deaths, table III-4. During this decade, a net out-migration occurred in all of the eight counties for a total of 14,629 people.

From 1940 to 1970, there was a natural increase of over 38,000 people; however, 70 percent of this increase was erased by out-migration. The loss of population through net out-migration during the 30-year period was about 27,000. This is greater than the combined population of the four largest towns in the study area.

Numerous side effects can be attributed to migration. Some of the age groups are affected more than others. A large proportion of those who migrate come from the productive age groups; i.e., productive in terms of economic and reproductive capacities. Changes in the composition of the area and states' populations from 1960 to 1970 are as follows:

Age group	Percentage change from 1960 to 1970				
	Wyoming portion	Montana portion	Study area	State of Wyoming	State of Montana
75+	+30.9	+16.9	+26.2	+43.0	+33.4
65-74	+10.8	-11.7	+ 3.3	+ 4.0	- 9.7
55-64	+31.0	+17.3	+27.0	+16.8	+21.6
45-54	+ 1.8	- 6.7	- 0.5	+ 3.5	+ 6.2
35-44	-11.4	-23.9	-14.5	-12.0	-12.8
25-34	- 9.2	- 9.1	- 9.2	- 8.1	- 0.9
15-24	+15.9	+ 8.4	+14.0	+31.4	+34.9
5-14	- 3.7	-11.8	- 5.7	- 0.5	+ 4.7
Under 5	-33.8	-33.5	-33.7	-30.1	-31.4

The Indian population as a whole is quite young when compared to the non-Indians. In 1970, the median age of Indians in the area was about 20 years as compared to about 29 years for all inhabitants. About 62 percent of the Indian population is under 25 years of age as contrasted to 45 percent for the other inhabitants. The difference in age composition between white and nonwhites (primarily Indians) is shown in figure III-1.

Formal education for the rural farm and nonwhite populations is below a comparable figure for the area population as a whole. In 1960, median school years completed for persons 25 years old and over were 10.8, 10.6, and 8.6, respectively, for all residents, rural farm residents, and the nonwhites. By 1970, comparable educational levels were 12.0, 12.1, and 10.8, respectively.

Figure III-1--Population distribution in percentages by age group and race, 1960 and 1970--Wind-Bighorn-Clarks Fork study area

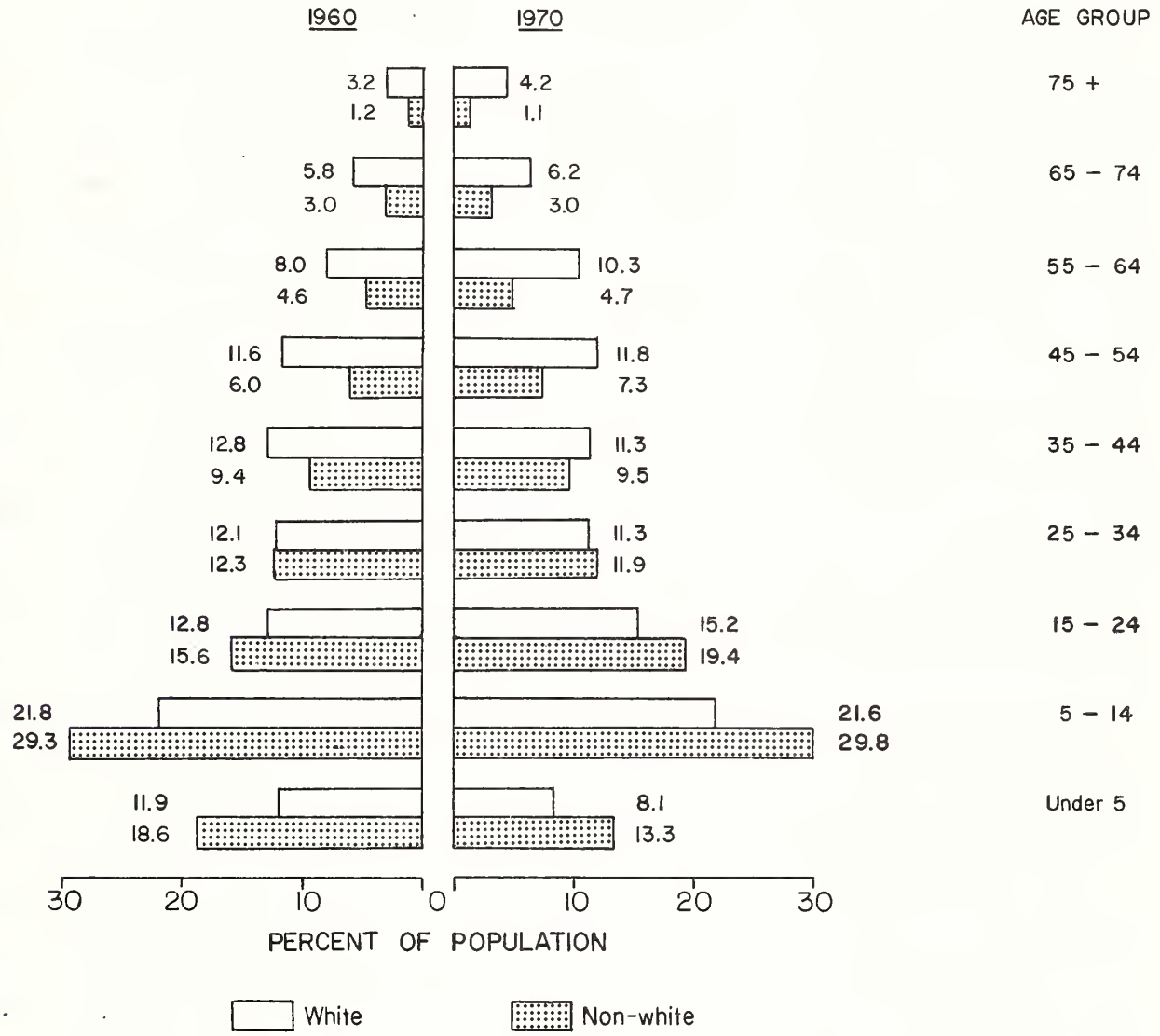


Table III-4--Components of population change, 1940-1970
Wind-Bighorn-Clarks Fork study area

Component	Wyoming portion		Montana portion		Total area	
	Number	Percent	Number	Percent	Number	Percent
1940 population	50,447		27,978		78,425	
1940-1950:						
Natural increase 1/	9,194		2,434		11,628	
Net migration 2/	799	+ 1.6	-4,931	-17.6	- 4,132	- 5.3
Population change	9,993		-2,497		7,496	
1950 population	60,440		25,481		85,921	
1950-1960:						
Natural increase 1/	12,823		3,467		16,290	
Net migration 2/	-3,075	- 5.1	-5,098	-20.0	- 8,173	- 9.5
Population change	9,748		-1,631		8,117	
1960 population	70,188		23,850		94,038	
1960-1970:						
Natural increase 1/	8,683		2,084		10,767	
Net migration 2/	-10,464	-14.8	-4,165	-17.5	-14,629	-15.6
Population change	- 1,781		-2,081		- 3,862	
1970 population	68,407		21,769		90,176	

1/ Births to resident mothers minus death of residents.
2/ Population change minus natural increase.

Labor force and employment

About 32.5 percent of the population of the Montana part of the basin is employed. This compares to about 35.2 percent employment for the State of Montana. In Wyoming the comparable figures are 37.0 and 37.1 percent.

The labor force includes all employed persons as well as those currently unemployed but seeking employment. About 57 percent of those 16 years old and older were in the labor force in 1970. Comparable labor force participation rates for Montana and Wyoming are 51 and 59 percent respectively. Most of the labor force is between 25 and 64 years of age. This age group is gradually becoming a larger part of the total as young people delay entry into the labor force due to educational opportunities and job training requirements. Improved retirement benefits are also attracting older workers to withdraw from the labor force. The 5 percent average unemployment rate in the study area is about the same as the national average unemployment rate.

There are numerous workers in the study area whose labor is under-utilized; thus, their income is less than what it might be. Underemployment differs from unemployment only in that human resources are partially utilized. An unemployed person cannot find work while an underemployed

person can find work, but at an amount less than he desires. Causes of underemployment are many and varied. When there is a lack of employment opportunities, some withdraw from the labor force rather than seek new jobs. Another cause is the immobility of people, especially those over 45 years of age. They are reluctant to leave familiar surroundings even if employment opportunities appear elsewhere. The natural surroundings of the basin intensify this type of attitude for some workers. Fishing, hunting, and other outdoor activities are not readily sacrificed for added income. Also, many jobs are seasonal, leaving many unemployed or underemployed part of the year. Farming, food processing, mining, and recreational services may provide only seasonal employment. The tourist trade is limited almost entirely to the summer months, thus affecting many employees.

One technique for measuring underemployment is to determine whether or not incomes are below capacity.[1/] County income capacities are measured by age, educational status, and other selected attributes of the labor force. They are compared with similar measures for the nation as a whole. In 1960, study area underemployment rates were 15 percent of the male labor force and 40 percent of the female labor force for a combined 21 percent of the total labor force. Severe underemployment exists at 20 percent or over. Underemployment rates are even higher on the Indian reservations.

The increase in population from 1940 to 1960 was closely related to the growth in nonfarm employment oppotunities. Total employment increased 33 percent during the period despite a continuing decrease in agricultural employment (table III-5). In 1970 total employment was 32,374. This was 263 less than a decade earlier. Employment in the Montana portion of the study has been on the decline during most of the last three decades while employment has been increasing in the Wyoming portion. It should be recognized that employees of agriculturally related firms are not included with agricultural employment, but appear in manufacturing, distributive, and service categories.

Basic industries of the area include agriculture, forestry, mining, and manufacturing. In 1940, they provided 58 percent of all jobs; by 1970 only 34 percent. Agriculture-forestry is the only major industry where employment declined continuously over the 30-year period. Construction employment has declined since 1950 after one decade of fantastic growth. All other sectors generally have expanded since 1940.

Male employees accounted for only 500 more jobs in 1970 than in 1940. Meanwhile, female job holders increased 222 percent. One reason for this

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1/ Income capacities were determined by comparing selected attributes of the male and female labor force in this study area to like attributes for the nation as a whole. Reported median incomes for the study area were then compared with an imputed median income which reflects the earning capacity of the labor force if incomes were the same as for the national labor force with similar earnings characteristics. Thus if reported income is less than imputed income, income is below capacity; such is the case in the study area. The ratio between these indicators measures the amount of underemployment.

Table III-5--Employment by industry--Wind-Bighorn-Clarks Fork study area

Industry	1940	1950	1960	1970	Percentage change			Percentage Distribution	
					40-50	50-60	60-70	1960	1970
Agriculture & forestry	12,388	10,951	7,660	5,511	- 11.6	- 30.1	- 28.1	23.5	17.0
Mining	793	1,681	3,128	3,041	+112.0	+ 86.1	- 2.8	9.6	9.4
Construction	1,307	3,330	2,474	2,189	+154.8	- 25.7	- 11.5	7.6	6.8
Manufacturing									
Food products	(350	(380)	(523)	(515)	+ 8.6	+ 37.6	- 1.5		
Lumber products	(212	(147)	(180)	(252)	- 30.7	+ 22.4	+ 40.0		
Other	(498	(806)	(1,085)	(1,669)	+ 61.8	+ 34.6	+ 53.8		
Total manufacturing	1,060	1,333	1,788	2,436	+25.8	+34.1	+36.2	5.5	7.5
Transportation, Communications, and utilities	915	1,909	2,228	1,910	+108.6	+ 16.7	- 14.3	6.8	5.9
Wholesale trade	349	561	539	819	+ 60.7	- 3.9	+ 51.9	1.6	2.5
Retail trade	2,610	3,954	5,227	5,582	+ 51.5	+ 32.2	+ 6.8	16.0	17.2
Finance, insurance, and real estate	242	603	687	808	+149.2	+ 13.9	+ 17.6	2.1	2.5
Services	3,591	4,584	6,706	8,136	+ 27.6	+ 46.3	+ 21.3	20.5	25.2
Government	823	1,212	1,394	1,942	+ 47.3	+ 15.0	+ 39.3	4.3	6.0
Not reported	387	493	806	0	+ 27.4	+ 63.5	N.A.	2.5	--
Total	24,465	30,611	32,637	32,374	+ 25.1	+ 6.6	- 0.8	100.0	100.0
Male	21,135	24,619	23,807	21,646	+ 16.5	- 3.3	- 9.1	72.9	66.9
Female	3,330	5,992	8,830	10,728	+ 79.9	+ 47.4	+ 21.5	27.1	33.1
Wyoming portion	15,953	22,001	24,790	25,289	+ 37.9	+ 12.7	+ 2.0	N.A.	N.A.
Montana portion	8,512	8,610	7,847	7,085	+ 1.2	- 8.9	- 9.7	N.A.	N.A.
State of Wyoming	86,559	114,715	123,309	123,389	+ 32.4	+ 7.5	+ 0.1	N.A.	N.A.
State of Montana	185,564	220,468	237,598	244,608	+ 18.8	+ 7.8	+ 3.0	N.A.	N.A.

Source: U.S. Census of Population

expansion is that farm women typically are not counted as a part of the labor force, although they may contribute significantly to agricultural output. However, as farm women seek off-farm employment or as they migrate from farms and obtain jobs, they are counted in the labor force. Secondly, there is a tendency for some women who have finished rearing their families to find jobs in service-type industries. More of these jobs are becoming available, and quite often they can be filled by workers with very little specialized training.

Economic activity in business and manufacturing sectors is shown in table III-6. Trends in the number of establishments vary by industry. Incomplete reporting of the dollar value of business activity somewhat obscures any trends.

Income

Personal income is another measure that can be used to reflect the economic well-being of an area. Total personal income for residents of the study area increased from 38 million dollars in 1940 to 286 million in 1970, table III-7. This is an increase of 660 percent as compared to 775 percent for the nation. Per capita income increased during the period. However, in 1970 it was 19 percent below the national average. Total personal income, after adjustment to a 1967 dollar base, is also shown in table III-7. The implicit price deflator for personal consumption expenditures at the national level was used to eliminate the influence of price inflation.

Income per family in the study area is lower than for the states of Wyoming and Montana. Also, many of the counties have a larger percentage of families below the poverty level (as defined by census). Variations between areas and location of residence are shown as follows:

Area	Percentage of families with income below poverty level		
	All families	Rural nonfarm	Rural farm
Wyoming portion	10.6	11.7	13.7
Big Horn Co.	9.6	9.0	11.9
Fremont Co.	11.8	16.4	21.0
Hot Springs Co.	12.9	11.3	15.2
Park Co.	7.9	8.1	8.4
Washakie Co.	12.2	9.8	11.2
Montana portion	16.7	18.3	16.7
Big Horn Co.	21.4	31.6	21.0
Carbon Co.	14.3	15.5	11.3
Stillwater Co.	12.5	10.3	17.3
Study area	12.1	13.9	14.8
State of Wyoming	9.3	10.2	12.1
State of Montana	10.4	12.3	14.1

Table III-6--Number of business establishments and reported economic activity, 1958-67
Wind-Bighorn-Clarks Fork study area

Item	Unit	1958	1963	1967
Wholesale trade:				
Establishments	No.	186	168	164
Sales	$Million 2/	41.1	43.7	56.3
Retail trade:				
Establishments	No.	1,184	1,199	1,178
Sales	$Million 2/	106.8	126.0	127.6
Selected services:				
Establishments	No.	718	815	778
Receipts	$Million 2/	10.6	16.8	20.3
Mineral industries:				
Establishments	No.	320	343	238
Shipments and receipts	$Million 2/	251.1 1/	286.0 1/	264.9 1/
Manufacturing:				
Establishments	No.	98	112	100
Value added	$Million 2/	9.7 1/	16.5 1/	15.3 1/

1/Part of the data has been withheld to avoid disclosure of individual firms.

2/Current dollars.

Source: U.S. Census of Business; U.S. Census of Manufacturers

Table III-7--Personal income and earnings by broad industrial sector for selected years, Wind-Bighorn-Clarks Fork study area

Category	1940	1950	1959	1966	1968	1970
	thousands of dollars 2/					
Total personal income	37,637	117,693	169,693	218,736	246,635	285,946
Per capita income 1/	480	1,370	1,851	2,397	2,710	3,171
Wyoming portion	476	1,359	1,904	2,538	2,916	3,294
Montana portion	492	1,397	1,696	2,006	2,133	2,784
Per capita income rel. to U.S. = 100	81	92	86	81	79	81
Wyoming portion	80	91	88	86	85	84
Montana portion	83	93	78	68	62	71
Total earnings	32,803	98,308	139,666	174,652	194,885	220,879 4/
Farm earnings	15,210	36,056	31,472	30,568	31,168	29,842
Total nonfarm earnings	17,593	62,252	108,194	144,084	163,717	191,037 4/
Gov't earnings	4,997	11,682	20,885	33,674	39,091	47,157
Private nonfarm Earnings	12,596	50,570	87,309	110,410	124,626	143,880 4/
Manufacturing	1,399	4,800	5,835	11,811	14,698	18,387
Mining	921	5,023	18,919	21,694	26,701	30,228
Contract constr.	1,214	8,299	11,465	14,839	15,107	16,612
trans., comm., & public utilities	1,374	4,932	9,099	10,471	11,859	13,187
Wholesale and retail trade	5,230	18,348	24,944	25,207	26,510	29,508
Finance, insurance, and real estate	368	1,976	3,046	4,554	5,075	5,492
Services	2,056	7,095	13,440	20,739	23,520	28,484
Other	34	97	561	1,095	1,156	1,353
	thousands of dollars 3/					
Total personal income	94,565	162,335	191,743	224,345	238,064	253,051
Per capita income 1/	1,206	1,890	2,088	2,459	2,616	2,806

1/ Per capita income is shown in dollars.
2/ Current dollars.
3/ 1967 constant dollars.
4/ Includes $629,000 of manufacturing and contract construction earnings not shown separately to avoid disclosure.

Source: Office of Business Economic Information System.

Wages, salaries, proprietors' income, and other labor income are combined and referred to as earnings. They account for 77 percent of total personal income in 1970. Total earnings are shown in table III-7. In 1940, farm earnings accounted for 46 percent of the total and then declined to 14 percent in 1970. Meanwhile, another basic industry--mining--(includes minerals and petroleum) had earnings that grew from 3 percent to 14 percent of the total. Although the local income is significant, total income from tourism and employment in services to tourists has not been separated from all services. Earnings from manufacturing and construction are relatively small, but this status may be altered in the near future as water conduits and industrial plants to support development of coal fields in and adjacent to the study area are developed.

Projections

Total population is projected to increase 54 percent by 2020 to a total of 138,700 people, table III-8. Meanwhile, the rural farm segment will continue to decline and will contain only 8 percent of all inhabitants by 2020. It is estimated that total population of the nation will double during this time. Total employment is also projected to increase. All of the increase will occur in nonagricultural sectors. Agricultural employment is projected at 4,450 in 1980; 3,600 in 2000; and 3,300 in 2020. Estimates of per capita income are also included in table III-8.

The above projections are somewhat governed by an extension of historical trends in major sectors of the area economy. Very recent developments in the mining industry may alter future conditions considerably. Large deposits of coal are known to exist in southeastern Montana and northeastern Wyoming including parts of the basin. The total resource is estimated in many billions of tons and much of it can be strip mined. Current annual production is very small in relation to the total resource. Production is increasing rapidly, and the potential for further development is favorable if large quantities of water are delivered to the coal fields.

How much the above projections will be affected by coal developments is a function of the type as well as the amount of development. If this resource is exported as a raw material, fewer employees will be required than if the coal is processed and exported as some other form of energy. The level of skills required of the employees will also vary according to the amount of processing done. This is turn may be reflected in per capita income. Very recent trends in the population growth of the nation are somewhat lower than the rates used for the projections in this report. A nationally consistent set of lower population projections for small areas were not available for use in this report.

Urban centers and transportation

In addition to the urban areas within the study area, two cities exert considerable influence upon the local economy. Billings, Montana, is located adjacent to the northern edge of the basin; and Casper, Wyoming, is about 50 miles southeast of the basin. Each of these cities has a

Table III-8--Projected population, employment, and per capita income, Wind-Bighorn-Clarks Fork study area

Item	1970	1980	2000	2020
Population:	90,176	97,100	116,200	138,700
Rural farm	17,070	14,400	12,200	11,300
Employment:	32,374	35,800	44,100	54,200
Agricultural	5,511	4,450	3,600	3,300
Other basic	5,477	6,000	6,300	6,200
Non-basic	21,386	25,350	34,200	44,700
Per capita income 1/	2,806	3,800	7,000	12,700
Per capita income relative to U.S. = 100	81	80	86	89

1/ 1967 constant dollars.

Source: OBE data and census data adjusted to local conditions.

sound, basic petroleum industry, wholesale outlets, small manufacturing, and transportation industries. Billings is also largely dependent on agriculture, as it provides a principal market outlet for agricultural products. It also lends stability to the surrounding area by providing some off-season employment to farmers.

There are community hospitals in most of the larger towns and more complete medical facilities in Billings. Most of the towns and some farms receive natural gas and electricity from power companies. The rest of the basin is served by rural electric cooperatives. Almost all of the town and farm residences have telephone service.

Interstate highways 90 and 94 are nearly completed in the basin. Other highways include U.S. 14, 16, 20, 26, 87, 212, 287, and 310, and many state highways. All of the larger population centers are served by one or more of the major highways. The main line of the Burlington Northern Railway crosses the north end of the basin. Branch lines of Burlington Northern and the Chicago and Northwestern Railroad also serve parts of the basin. Scheduled airline service is available at Cody, Riverton, and Worland, Wyoming. This service is not available in the Montana part of the basin, but several airlines serve Billings on regular schedules.

AGRICULTURE AND RELATED ACTIVITY

General

Agriculture is an important segment of the study area economy. Although the number of farms and farm operators is declining, agriculture is an expanding industry. It is expanding in terms of total value of production as well as product diversification. The inverse relationship between increasing agricultural production and declining farm population stems largely from an increase in farm efficiency through the use of conservation programs, improved technology, feed additives, fertilizers, insecticides, and larger farm machinery. Further efficiencies are expected through the year 2020. Larger quantities of agricultural products will be required as population of the nation increases or as net exports increase. Rising per capita income leads to additional expenditures for many food items. As incomes expand, consumers tend to upgrade their diets, and this generally means eating more meat, especially beef. Beef cattle are the principal source of agricultural income. Most of the beef is sold as feeder cattle and calves. Cattle feeding is growing in importance toward the northern part of the basin. Expansion in cattle feeding will provide an outlet for silage and feed grains that are grown on land going out of sugarbeet production in the Montana portion of the basin. Sheep and lamb production is also important. Most lambs are sold for fattening outside the basin.

According to the Census of Agriculture, the amount of land in farms and ranches has remained fairly constant. In addition to these privately owned lands, livestock producers obtain grazing leases and permits for public lands, thus increasing the total amount of land used for agricultural production. Some of the characteristics of farms are subject to change (table III-9). Out-migration, particularly from the rural population, has been instrumental in the decline of farm numbers. The remaining farms are larger, produce more, and have a greater capital investment. Average farm size has a limited meaning in the study area because farm and ranch units vary from extensive livestock operations to those specializing in intensively irrigated row crops. In 1969, 20 percent of all units were less than 100 acres in size; and 27 percent were over 1,000 acres. About 75 percent of the land in farms is controlled by farms or ranches larger than 2,000 acres.

The per acre value of land and buildings nearly tripled between 1954 and 1969. This was partially due to higher land prices and building construction costs and partially due to other capital investments such as irrigation equipment and drainage systems. The combination of higher price per acre and increased size has resulted in an average investment of greater than $130,000 per unit. Large capital requirements are also reflected in type of ownership. Apparently, some of the operators are satisfied to have less than full control of the land resource so they can obtain capital for current operations. Also, the returns to operating capital are often higher than the returns to capital invested in land. Little change



Modern Large feedlots are being developed in the Basin to utilize local feed for local cattle. (Yellowstone County above; Carbon County below)



PLATE 14



Most of the dry cropland is stripcropped and some of it is protected with single-row windbreaks which also provide wildlife habitat.





Dryland farming, by nature, is big enterprise farming.

PLATE 15

Table III-9--Characteristics of farms in the Wind-Bighorn-Clarks Fork study area

Item	Unit	1954	1959	1964	1969
Farms	Number	5,855	4,918	4,476	3,942
Average farm size	Acre	1,864	2,265	2,600	2,793
Ownership class:					
Full owner	Percent	51	45	46	48
Part owner	Percent	29	35	38	38
Tenant	Percent	20	20	16	14
Size class:					
Under 100 acres	Percent	21	17	16	20
100-179 acres	Percent	21	17	14	11
180-259 acres	Percent	11	11	10	9
260-499 acres	Percent	17	20	21	18
500-999 acres	Percent	11	13	14	15
Over 1,000 acres	Percent	19	22	25	27
Value of land and buildings:					
Per farm	Dollars 1/	30,558	48,973	82,332	131,025
Per acre	Dollars 1/	16	22	32	47

1/ Current dollars

Source: U.S. Census of Agriculture

can be expected in this trend as farm size, land values, and machinery costs continue to increase.

Agriculture also provides many of the primary inputs to other sectors of the economy. Sugarbeet refineries, food processing plants, marketing, and transportation facilities are heavily dependent upon the crops and livestock produced locally. The amount of processing done locally varies between products. Processing can range from little, if any, for feed grains to providing a finished product, such as sugar. Farmers, ranchers, and their families are an important source of labor. They can supplement farm income with seasonal, part-time, and, in some cases, full-time jobs.

In 1969, 1,746 farm operators (44 percent of the total) reported that they worked off their farms. Twenty percent (801) of all farmers worked away from their farms at least 200 days in that year. An additional 8 percent has a similar status for 100-199 days.

Among those that reported working away from their farm, 1,189 operators maintain commercial farms, i.e., farms with agricultural product sales of $2,500 or more. Thirty-two percent of the commercial farm operators in the Montana study area that held jobs worked at these jobs 200 days or more per year. A comparable measure for the Wyoming study area is about 38 percent.

Land use and production

There are approximately 9.2 million acres of agricultural land in the basin that were inventoried during 1967 to determine use and conservation treatment needs. 1/ About 4.1 million acres are in the Montana portion and the remaining 5.1 million acres in Wyoming. Most of this privately-owned land is used to provide roughage, grazing, and feed grains in support of the livestock industry. Land uses include irrigated pasture and cropland, nonirrigated cropland, range, forest, and other agricultural uses. Some additional land may be required for highways, urban, and built-up areas within the planning horizon of this study. The amount of agricultural cropland is expected to remain close to the present acreage. However, recent significant increases in international agricultural trade are resulting in reactivation of diverted acres and conversion of some rangeland to cropland. At present there are no projections available for future rates of the foreign trade or the degree of land use conversion. There is also expected to be some conversion of nonirrigated to irrigated cropland.

Irrigated crops that are grown include hay, sugarbeets, corn, small grains, dry beans, canning crops, silage, and pasture. Dryland crops are mainly wheat, barley, and hay. The production of corn for grain and silage is increasing and is used locally by feedlot operators. The acreage of dry beans has declined substantially in the entire basin. Competing areas

1/ Conservation Needs Inventory, Wyoming, 1967
Conservation Needs Inventory, Montana, 1967

have attracted dry bean and legume seed production away from the basin. The sugar beet acreages declined about 14,000 acres with the recent closing of the sugar plant at Hardin. Also, alternative crops are now more profitable to produce. In the Wyoming portion, malting barley has replaced much of the dry bean production. Malting barley is a relatively new crop to the basin, but a potential exists for further expanding production since the altitude and climate lend to growing a desirable product.

Barley, oats, and corn are used primarily as feed and marketed as livestock or livestock products. New high yielding and early maturing varieties of corn for silage have been developed for this area. Improved methods of storage have also enhanced production. Federal farm programs also influence land use.

There are about 763,000 acres currently irrigated and over 353,000 acres of cropland without irrigation facilities. Crop-fallow rotations are used for the dryland grain crops, primarily because of insufficient rainfall, but also due to federal agricultural policy favoring the practice. Present and projected cropland and range acreages are shown in table III-10. The amount of irrigated land is expected to increase 28,300 acres by 1980; another 30,500 acres by 2000; and another 35,300 acres by 2020. Total irrigated land is expected to be 857,000 acres in 2020. Nonirrigated cropland and rangeland will decrease slightly as a result of increased irrigation. Lands suitable for irrigation on public land may be available for future development through an exchange agreement. However, this was not considered in the projections.

Productivity per acre has been increasing and can be expected to expand further until 2020. Present and projected crop yields were calculated independently for the Wyoming and Montana portions of the basin as shown in table III-11.

Present and projected production for the major commodities is shown in table III-12. For most of the crops, present production is a weighted average for 1965-1970. The amount of grazing on public lands and Indian Reservations was obtained through the federal agencies issuing grazing leases and licenses. Currently, public lands provide 34 percent of the grazing resource. Production of livestock commodities was determined by relating current inventories and sales for the portions in each state to their respective state totals and then converting to units of weight.

Projected production from the basin is based upon the estimated national rate of increase (or decrease) for each commodity for each time period. These rates were altered upward or downward for some items through historical comparisons of significant trend changes between states. Corn for grain, barley, and oats were adjusted upward in both state portions of the basin. Sugarbeets were increased for the Wyoming portion. Downward adjustments were made for dry beans and some minor livestock commodities. Beef and sheep, the important items in the livestock sector, approximate the national rate. National projections of agricultural products are influenced by population growth, income, consumer tastes and preferences, per capita consumption, exports and imports, as well as industrial uses.

Table III-10--Present and projected land use on state and private land [1]--Wind-Bighorn-Clarks Fork study area

Crop	Present [2]	1980	2000	2020
	acres			
Irrigated cropland:	763,024	791,300	821,800	857,100
Wheat	12,000	10,900	10,000	9,000
Barley	54,200	68,000	78,000	83,000
Oats	31,200	25,200	22,700	21,200
Corn, grain	6,000	10,900	18,900	21,100
Sugarbeets	51,700	44,400	60,400	74,600
Dry beans	20,800	14,800	14,300	13,900
Vegetables [3]	1,500	1,000	1,200	1,300
Silage	28,500	34,800	38,000	40,000
Alfalfa hay	213,900	224,000	222,500	227,100
Other hay	137,000	137,000	137,000	137,000
Pasture	158,000	172,600	171,100	181,200
Other crops	8,500	8,500	8,500	8,500
Not harvested	39,724	39,200	39,200	39,200
Nonirrigated cropland:	353,592	341,800	349,900	349,000
Wheat	115,670	102,700	107,600	103,600
Barley	40,700	49,000	54,000	58,700
Oats	4,300	3,600	3,800	3,700
Hay	33,500	36,000	34,000	33,000
Fallow	159,422	150,500	150,500	150,000
Range	7,254,543 [4]	7,238,050	7,199,450	7,165,050

1/ Does not include forested land and other uses.

2/ Present use of cropland generally represents a weighted average for 1965 through 1970.

3/ Mostly potatoes.

4/ Dry pastureland not included.

Most of the agricultural commodities produced in the basin, except for feed grains and roughages, are marketed for consumption, processing, or fattening in other localities or states. The significant aspects of cattle and sheep production are the cow-calf and ewe-lamb enterprises that provide feeders to feedlots. Projections of hay and grazing are based upon the amount of each needed to supply adequate roughage. The amount of roughage from grazing public and private ranges was added to the amount produced on irrigated land and from nonirrigated hay. It was assumed that any additional roughage would come from new hay, pasture, and silage crops. Consequently, most of the increase in irrigated acres is reflected in these roughage crops. One exception is beet tops. It is assumed that all sugarbeet tops are fed as silage or grazed.

Table III-11--Present and projected crop yields per harvested acre by subareas--Wind-Bighorn-Clarks Fork study area

Crop/Subarea	Unit	Yield per acre			
		Present	1980	2000	2020
Irrigated crops:					
Wheat-Wyoming	Bu.	38	42	54	66
Wheat-Montana	Bu.	41	47	59	72
Barley-Wyoming	Bu.	63	80	96	113
Barley-Montana	Bu.	53	74	93	106
Oats-Wyoming	Bu.	54	69	85	101
Oats-Montana	Bu.	62	80	99	109
Corn, grain-Wyoming	Bu.	69	85	96	108
Corn, grain-Montana	Bu.	71	93	115	135
Sugarbeets-Wyoming	Ton	17.0	19.9	24.5	29.4
Sugarbeets-Montana	Ton	16.6	20.1	24.1	29.1
Dry beans-Wyoming	Cwt.	16.4	20.1	25.2	30.0
Dry beans-Montana	Cwt.	16.5	20.1	23.9	27.6
Vegetables-Wyoming 2/	Cwt.	195	300	350	400
Silage-Wyoming	Ton	15.0	18.0	23.2	27.1
Silage-Montana	Ton	18.1	23.3	28.4	31.1
Alfalfa hay-Wyoming	Ton	2.8	3.2	3.7	4.3
Alfalfa hay-Montana	Ton	3.0	3.6	4.3	5.0
Improved grass hay-Wyoming	Ton	1.3	1.8	2.3	2.8
Native hay-Wyoming	Ton	1.1	1.3	1.6	2.0
Other hay-Montana	Ton	2.4	2.8	3.4	4.0
Permanent pasture-Wyoming	F.U. 1/	1,680	1,980	2,240	2,470
Rotation pasture-Wyoming	F.U. 1/	2,330	2,690	2,970	3,220
Pasture-Montana	F.U. 1/	2,100	2,520	2,940	3,360
Nonirrigated crops:					
Wheat-Wyoming	Bu.	24	30	39	48
Wheat-Montana	Bu.	27	32	36	42
Barley-Wyoming	Bu.	27	34	42	50
Barley-Montana	Bu.	35	40	47	55
Oats-Montana	Bu.	37	42	49	56
Hay-Montana	Ton	1.3	1.6	1.8	2.0
Range-Wyoming	F.U. 1/	123	157	183	198
Range-Montana	F.U. 1/	100	120	141	160

1/ Feed Unit: One feed unit is equivalent to one pound of shelled corn.

2/ Mostly potatoes.

Table III-12--Current and projected production and values of production--Wind-Bighorn-Clarks Fork study area

Crop	Unit	Current	1980	2000	2020
Wheat	Bu.	3,601,330	3,785,400	4,456,900	4,998,000
Barley	Bu.	4,711,670	7,304,000	9,967,000	12,463,000
Oats	Bu.	1,880,960	1,925,000	2,158,000	2,373,000
Corn, grain	Bu.	420,210	981,000	2,078,000	2,684,000
Sugarbeets	Ton	874,460	885,400	1,475,900	2,189,300
Dry beans	Cwt.	341,220	297,000	356,000	410,000
Vegetables 6/	Cwt.	292,500	300,000	420,000	520,000
Silage	Ton	469,400	721,400	985,600	1,171,800
Alfalfa hay	Ton	611,340	742,800	862,600	1,022,000
Other hay	Ton	272,500	347,200	421,700	499,200
Pasture	AUM 2/	641,133	825,373	934,593	1,096,609
Range	AUM 2/	1,517,751	1,903,804	2,219,578	2,438,751
Range 4/	AUM 2/	1,119,858	1,127,084	1,182,444	1,182,444
Beef	Lb. 1/ 3/	193,110	261,820	353,700	463,711
Pork	Lb. 1/ 3/	12,684	14,520	16,900	20,000
Sheep	Lb. 1/ 3/	18,947	16,230	19,310	22,380
Wool	Lb. 1/	3,600	3,084	3,670	4,252
Milk	Lb. 1/	70,000	61,200	68,600	77,800
Eggs	Doz. 1/	2,715	2,615	3,080	3,637
Poultry	Lb. 1/ 3/	522	527	625	738
Aggregate value of production	Dol. 1/ 5/	125,501	154,339	199,540	249,183
Value of feed utilized	Dol. 1/ 5/	50,322	63,302	76,302	88,205
Gross value of production	Dol. 1/ 5/	75,179	91,037	123,238	160,978

1/ Units in thousands.

2/ One feed unit has the equivalent feeding value as one pound of shelled corn. One animal unit month (AUM) = 450 feed units.

3/ Live weight basis.

4/ Grazing obtained through leases and licenses administered by federal agencies.

5/ Price standards from "Interim price standards for planning and evaluating water and land resources, Water Resources Council, April 1966," were used to the extent possible.

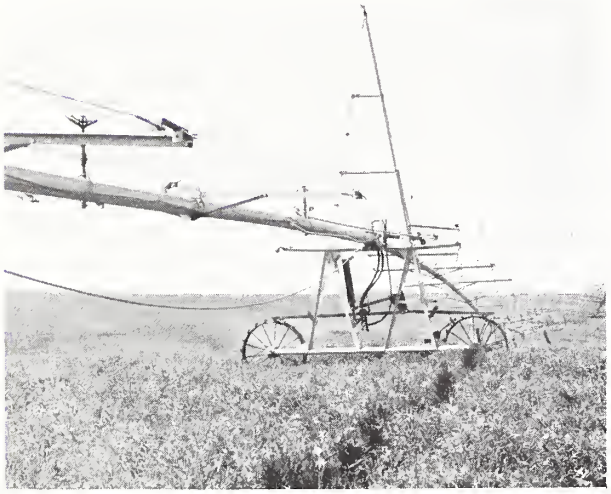
6/ Mostly potatoes.



Corn for silage and grain is increasing in importance.



Good yields of alfalfa are possible with full water supplies, good drainage, fertilizer, and good irrigation management. (Clarks Fork Valley)



Sprinkler systems are bringing land under irrigation that is too rough or has soils unsuited for irrigation under conventional systems.



About 6,000,000 cubic feet of industrial wood products came from the basin in 1962.

U.S. FOREST SERVICE PHOTO



By 1980 the demand for the basin's timber products is expected to exceed the supply by 3,000,000 cubic feet per year.

Currently, the amount of grain fed is in excess of production. Feed grain production is projected to increase 46 percent by 1980, 113 percent by 2000, and 150 percent by 2020. It is likely that the deficit will continue at least through 1980. Sugarbeet production will increase slightly by 1980 and increase 2½ times by 2020. Also by 2020, wheat and dry beans will increase 40 and 20 percent, respectively, over current production. Beef production is projected to increase 35 percent by 1980 and 140 percent by 2020. Sheep and milk production will decline by 1980 and then increase.

There are nmmerous considerations inherent in making projections for any commodity or geographic area. The foregoing projections are based upon national trends that are adjusted for local conditions. The demand for goods and services produced by water and land resources of the basin is influenced by market conditions in other areas. A large part of the agricultural output is exported as intermediate or final products that will eventually be consumed outside of the basin. The agricultural commodities produced are not unique to this basin, as they are also produced in competing areas throughout the nation and the world. Consequently, local producers have little command over the prices for the products and services they provide.

The heavy reliance upon nonlocal markets combined with the competitive nature of goods and services produced imposes some important economic restrictions upon the extent of agricultural production. Projections of production for the basin reflect expected shares of the nation's output that will clear the market at current normal prices. If an excess is produced and marketed at the national level, the major effects will include either a decline in prices or an accumulation of surpluses. Large production increases may affect market prices to the extent that returns to agriculture are less than conditions prior to the expansion phase.

However, a change in demand for agricultural commodities at the national level will have a similar effect at the local level. Recently there has been a significant increase in international trade. If the increased demand for agricultural products from the U.S. continues, there will likely be a production increase in this basin.

There is the possibility that technology will not be available to increase crop yields to the extent as shown in the projections. If future cropland yields are overestimated by 10 percent, an additional 77,000 acres of irrigated and 19,000 acres of nonirrigated cropland would be needed by 1980 to provide the same level of output. By 2020, irrigated and nonirrigated cropland acreages would be 82,000 and 20,000, respectively, above their current levels. If future cropland yields are underestimated, then less than the projected area of new cropland will be required to provide the same level of output.

The importance of public lands as a source of grazing was indicated earlier. It is assumed that most of the public land will continue to be available to livestock producers. However, if this resource becomes no longer available, additional production from private lands will be essential. Over 183,000 acres of irrigated pasture would be required to replace the grazing on public lands in 1980. By 2020, about 150,000 acres of irrigated pasture could replace grazing on public land.

FOREST RESOURCES AND RELATED ECONOMICS

Timber

In 1970 the Forest Service and other agencies cooperated with the Office of Business Economics (OBE) and the Economic Research Service (ERS) to produce a national assessment of water and related land resources. One result is a projection of national timber supplies and demands to the year 2020, with intermediate projections for 1980 and 2000. The national projections were allocated to major water regions and to subbasins. Use of the projections enables planners to identify the share of national demands which the subbasin is expected to provide and to compare prospective supplies to the demands. In 1962, the base year of this assessment, [1/] the estimated volume of growing stock available was about 12 million cubic feet. In the same year the basin produced about 6 million cubic feet of industrial wood products.

By 1980 the demand for timber products is expected to exceed the supply by 3 million cubic feet or nearly 12 percent. The demand will continue to outstrip the supply by an increasing margin for the remainder of the time period of the study if current levels of management, market prices, and other conditions remain constant or maintain current trends in change (table III-13).

Table III-13--Projected annual volume of growing stock available [1/] and demand, 1980, 2000, and 2020--Wind-Bighorn-Clarks Fork River Basin, Montana and Wyoming

Year	Supply of available growing stock	Projected demand of domestic roundwood
	million cubic feet	
1980	23	26
2000	31	45
2020	31	51

1/ Net volume of growing stock trees available for harvest.

Source: U.S. Forest Service and OBE-ERS data prepared for the National Assessment of Water and Related Land Resources, July 1970 and revisions of June 1971.

Currently, the national forests are contributing about 66 percent of the total timber harvest in the basin. About 28 percent comes from

1/ The boundaries of the subbasin used in the assessment are not exactly identical with the boundaries defined in this report; however, the area of commercial forest land is approximately the same.

the Indian Reservations. The rest comes from public domain, state, or private forests.

In 1971 approximately 220 persons were employed by the logging and forest products manufacturing firms in the basin. The volume of timber processed in the basin is about equal to that harvested in the basin.

Outdoor recreation

National forest lands within the basin are significant suppliers of outdoor recreation sites. In 1970 there were approximately 3,240,000 visitor-days use on these areas. The major activities were sight-seeing, camping, resort use, hunting, and fishing.

It is easy to recognize that such an influx of recreationists has an important impact on the local economy. However, measuring this impact is difficult. One method is to estimate the average expenditures per visitor day. These expenditures will mainly occur in food markets, service stations, drinking and eating places, and apparel, gift, or sporting goods stores. A California recreation study 1/ estimated that campers, day-users, motel and lodge guests, and mountain-home occupants averaged per capita daily expenditure of $1.48, $1.62, $8.95, and $1.76 respectively. The study also estimated the distribution of average expenditures by type of sector.

Sales to visitors do not represent the entire impact of expenditures on the local economy. The total impact of the recreation, as part of the economic base, must include those values of sales affecting the local economy in terms of personal income and employment generation. However, the other components of the economic base which include agriculture, forestry, mining, and manufacturing also have similar multiplier effects. In fact, of these components, the recreation industry generally is characterized by lower multiplier values.

Recreation participation is expected to increase substantially by 2000 and 2020 because of population growth and greater participation rates. The socio-economic factors identified as being closely associated with recreation participation rates are income, age, education, occupation, place of residence, amount of leisure time, and gender. The supply will depend upon many factors. Some influencing factors are land capabilities, available financing, expected prices or returns, and government policies.

Recreation use in visitor days (12 hours of recreation activity) does not indicate the number of times that a particular activity was enjoyed. For example, it is assumed that one visitor day of picnicking may represent six people having one 2-hour picnic or one person having six 2-hour picnics. However, only one picnic unit can be occupied for each picnic. Also, the

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1/ R. Drake, et. al. Selected Economic Consequences of Recreation Development: Tuolumne County, Case Study, Agricultural Extension Service, University of California, Berkeley, No. 68-4, June 1968, 66 pp.

analysis of supply in visitor days assumes that a particular reaction unit is available for use during 12 hours each day, but a picnic table might be used only once (2-hour period) during a day. As much as 80 percent of the total use may occur during weekends and holidays. Striving to meet these peak demands with conventional facilities is economically inefficient due to the large percentage of idle capacity during the remaining periods.

RELATIONSHIP BETWEEN ECONOMIC DEVELOPMENT AND WATER RESOURCE DEVELOPMENT

Land and water resource developments for use in agricultural production were virtually unknown in the basin until the 1880's and 90's. The first were irrigation works built by individual farmers followed by developments made possible through the Carey Act. During this time, some of the land was denuded of its virgin cover and planted to vegetation that had water requirements greater than the amount available through the normal supply of rainfall. Sugarbeets, dry beans, alfalfa hay, and feed grains were no longer alien to this arid basin.

Crop production from irrigated lands became a progressively larger share of total agricultural production as more areas were irrigated. Currently, about two-thirds of the value of the basin's agricultural output can be attributed to the irrigated croplands. Both private and public investments have been put to use during the era of irrigation development. About 30 percent of the irrigated land has been developed as the result of federal reclamation projects. The remaining developments are about 10 percent in projects sponsored by the Bureau of Indian Affairs, and about 60 percent in private projects by individuals and by groups.

RESOURCES FOR RECREATION

Nearly all of the public and most of the private land and water areas in the basin are available for outdoor recreation. Trespass laws and other laws generally require the landowner's permission to use private lands for this or any purpose. User fees are often charged for the use of both private and public property or facilities. Profit and nonprofit indoor recreation facilities are generally available in the basin's larger towns.

The income from recreation activities in the basin is reflected in Table III-7, mainly in the entries for "Services" and "Other." Some of the "Wholesale and retail trade" is also the result of recreation activities. There is no way of knowing for sure, but the income to the basin from outdoor recreation is probably about $10,000,000 per year. Thus, it would rank first among the services and behind government, mining, wholesale and retail trade, construction, manufacturing, agriculture, and utilities and ahead of forestry as an income category.

To avoid unnecessary duplication in this report, most of the discussion about recreation is presented in Chapter V.



Picnicking and camping are among the more important uses of national forest lands in the Basin. USDA - FOREST SERVICE PHOTOS



PLATE 18



WYOMING TRAVEL COMMISSION PHOTO

Winter recreation use of national forest lands is rapidly increasing.



PHOTO

PLATE 19

IV. WATER AND RELATED LAND RESOURCE PROBLEMS

The water and related land resources of the basin are affected by both natural and people-made processes which tend to reduce the quantity and quality of those resources. Other problems are caused by an imbalance of resource availability (primarily water shortages). This chapter discusses some of these processes and imbalances, the problems they create, their magnitude, and effect.

EROSION DAMAGE

Erosion damages occur in varying degrees throughout the basin. The most serious types are streambank and gully erosion. Approximately 80 percent of the basin's erosion damage occurs in gullies and streambanks in the soft sedimentary formations which compose most of the basin floor and the alluvium along the valley bottoms. Some of this erosion has occurred because modern man disturbed the vegetation and water flow patterns in the basin.

Erosion is also a problem in mountain forest and rangelands when disturbed, because soils are generally young, thin, and have little structural development. About 125 miles of gullies, 4,100 acres of accelerated sheet and gully erosion, 30 miles of eroding streambanks, 270 miles of eroding roads and trails, and 85 acres of eroding mine areas have been inventoried on national forest lands. Many miles of inadequately maintained trails are a problem in the forested lands of the Wind River Indian Reservation.

Sheet and rill erosion damages are not serious problems in the basin, but they do occur. They result from both high winds and high flows of runoff water over inadequately protected soils. These damages have been accelerated by overgrazing rangelands and through improper cultivation practices on croplands.

Major causes of erosion damage are (1) high rates of runoff and streamflows in the spring and early summer, (2) sparse vegetative cover, (3) improperly located roads and trails, (4) inadequately constructed logging roads and skid trails, (5) off-road vehicular travel, (6) overgrazing, (7) wildfires, and (8) mining.

The economic and social costs of accelerated erosion include loss of productive land, reduced crop production, damaged fish and wildlife habitat, damaged recreation sites, decreased farming efficiencies, damaged structures, reduced land values, interrupted utility lines, and reduced aesthetics. However, much of the visible erosion in the basin is natural or geologic erosion which hasn't changed much since the days of John Colter or Jim Bridger. At present there is not an economical way to control this erosion significantly; and it may not be the best thing to do, since many of these areas are colorful and scenic. Most of these areas remain in public ownership.

SEDIMENT YIELD AND DAMAGES

Sediment damages are generally light, but do occur with varying severity throughout the basin. Agricultural lands, stream and river channels, water supplies, capital improvements, reservoirs, fish, wildlife, and aesthetic values of streams are all damaged by sediment. Most of the damage occurs in the floor of the basin, and most (about 78 percent) of the sediment source is from the same area. Figure IV-1 is a sediment yield map for the basin.

Most sediment damages to agricultural lands occur in the irrigated valleys. Nearly all of this sediment damage is associated with flooding, from both perennial and intermittent streams. At the same time, irrigation canals and structures trap sediment, and their transport capacities are reduced. Cleaning and repairing these canals increases crop production costs. About 20 percent of the total length of these canals is cleaned each year.

Aggradation occurs in some portions of streams due to an over-supply of sediment from the eroding portions. This reduces their capacities and increases flooding. It also promotes stream meandering, which causes increased streambank erosion and land loss in a repeating cycle down the stream.

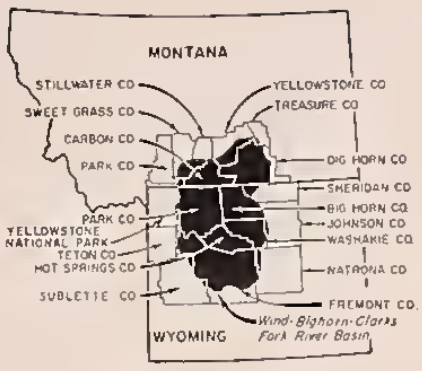
Suspended sediment loads in streams reduce water quality for irrigation, municipal, domestic, and industrial purposes. Some provision for filtering or settling out sediments must be provided in every municipal water treatment plant. The operation costs go up as sediment loads increase.

Sediment in streams can injure or kill fish and reduce fish reproduction by covering spawning beds. Other aquatic life may be similarly affected. This problem is serious enough on Clarks Fork River, below Big Sand Coulee, to attract the attention of fisheries biologists, fishermen, and other citizens and officials. Sediments originating from marine shales also carry undesirable salts into streams, stockwater reservoirs, and croplands, lowering the quality of the water for all downstream uses.

Reservoir capacities are reduced by the deposit of sediments. Table VI-1 lists estimated average annual sediment loads to selected reservoirs in the basin.

FLOODWATER DAMAGES

In general, historical data from field interviews and old newspaper stories do not indicate sufficient economic damage from floods to justify single-purpose flood prevention projects. Most flood damages occur on sparsely inhabited cropland areas on tributary streams. Mainstem flood damages are significantly reduced through the operation of large reservoirs such as Boysen, Buffalo Bill, and Bighorn Lake. Levees and channel works have reduced flooding in some urban areas. Table IV-2 gives a brief resume of newspaper records of floods and the watersheds in which they occurred.



LOCATION MAP

SEDIMENT YIELD
(Acre-feet per square mile per year)

- 1.0 – 3.0
- 0.5 – 1.0
- 0.2 – 0.5
- 0.05 – 0.2
- Less than 0.05

FIGURE IV-1

SEDIMENT YIELD

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

LAMBERT EQUAL AREA PROJECTION

Approximately 80 percent of the basin's erosion damage occurs in gullies and streambanks.





Inadequate control of irrigation tailwater can cause gully erosion.

Checking the depth of sediment deposits in Boysen Reservoir.



PLATE 20



Sediment accumulation of 36 years has reduced the storage capacity and attractiveness of Cooney Reservoir in Carbon County.



Overuse of stream bottom has destroyed browse and game habitat.

USDA - FOREST SERVICE PHOTO



Streambank erosion of sandy soils along Elbow Creek.



Permeable log jetties constructed on the Bighorn River in an attempt to control bank erosion.

Table IV-1--Sediment yields to selected reservoirs based on suspended load and/or reservoir surveys, Wind-Bighorn-Clarks Fork River Basin

Reservoir name and subbasin	Drainage area above reservoir	Sediment yield average annual	
		Total	Per square mile
	(square miles)	acre-feet	
Boysen Reservoir	7,767	1,398	0.18
Bighorn Reservoir			
Bighorn River	8,598	3,525	0.41
Shoshone River	1,492	746	0.50
Buffalo Bill Reservoir	2,023	708	0.48

Source: River basin planning staff files

Floods have caused damage to crops, livestock, bridges, roads, machinery, fences, farm buildings, and homes. Residential areas have been flooded in the towns of Lander, Hudson, Thermopolis, Worland, Greybull, Red Lodge, Lodge Grass, and along Blue Creek.

The town of Lander has had at least two serious floods in recent years. Because of the threat of flooding, the city has taken action to improve the hydraulic characteristics of the river channel through the city. The town probably spends more each year to prevent flooding than any other town in the basin. As long as this practice is maintained and new buildings are kept out of the floodplain, only very rare floods can cause serious damage.

Both the Nowood and Bighorn Rivers have caused flooding in the small town of Manderson. Average annual damages are about $39,500. The water wells for the town of Joliet were flooded in 1964. As a partial result, new wells were drilled outside the flooded areas. The town of Fishtail often receives winter flooding caused by ice build-up in West Rosebud Creek during the fluctuating operations of the Mystic Lake Power Plant by the Montana Power Company.

Table IV-3 lists estimated average annual flood damages on selected drainages in the basin. Estimates of total flood damages in the entire basin were made for the Missouri River Basin Comprehensive Framework Study for present and projected economic conditions. Areas subject to flooding are listed in table IV-4.

Table IV-2--Occurrence of major floods, selected watersheds, 1960-1970

Watershed	Year										
	60	61	62	63	64	65	66	67	68	69	70
Crow Creek				M[1]		S[2]					
Little Popo Agie River			S	S		S				M	
Candy Jack Watershed	S		S	S				S			
Badwater Creek				M				M	S		
Nowood River			S	M		M		S			S
Greybull River		M	M	S	M	S		S	M	M	M
Shell Creek		S	S	S	M	S		M	S	M	M
Shoshone River		S	S	S		S		S	M		
Fishtail				M				S	S		
Blue-Duck Creek				S	S	S				S	
Pryor Creek				S	S	S					
Clarks Fork-Ruby Creek					S						
Red Lodge-Rock Creek			S	M				S	S		
Two Leggins				S				S			
Lodge Grass Creek						S				S	

1/ M = Moderate flooding. These floods were serious enough to be reported in local newspapers.

2/ S = Serious flooding. These floods were serious enough to merit special effort in reporting by the editor of the local newspaper. Compiled from field interviews and local newspaper accounts.

Table IV-3--Estimated average annual flood damage on selected drainages

Drainage area name	Floodplain area	Average annual damages 1/					
		Crop and pasture	Other agri-cultural	Other rural	Urban or residential	Indirect	Total
	---acres---	---dollars---					
Wyoming							
Crow Creek	40	170	9,580		0	980	10,730
Little Popo Agie	2,300	16,750	8,650		5,200	3,300	33,900
Upper Badwater	250	420	880		0	130	1,430
Nowood River	5,900	26,000	39,000		39,510	12,430	116,940
Subtotal for Wyoming	8,490	43,340	58,110		44,710	16,840	163,000
Montana							
Stillwater River Sub-basin	3,400	2,400		6,100	5,000	N/A	13,500
Clarks Fork Sub-basin	15,200	20,400		33,500	16,000	N/A	69,900
Bighorn Sub-basin (Incl. Little Bighorn)	32,500	30,100		42,900	58,400	N/A	131,400
Yellowstone minor tributaries	29,800	53,600		80,300	104,600	N/A	238,500
Subtotal for Montana	80,900	106,500		162,800	184,000	N/A	453,300

1/ Price Bases: Wyoming portion - 1970. Montana portion - Urban and "other rural" - 1960; Crop and Pasture - 1964

Sources: Wyoming portion: River Basin Staff analysis of selected watersheds.

Montana portion: Missouri River Basin Comprehensive Framework Study and River Basin Planning Staff analysis.

Table IV-4--Summary of current and projected flood damages

State portion	Area subject to flooding	Average annual flood damages 1/			
		Under current economic development	Under projected economic development without flood protection 2/		
			1980	2000	2020
	1,000 acres	1,000 dollars	1,000 dollars		
Wyoming	132.5	469.0	787.0	1,461.0	2,628.0
Montana	80.9	453.3	577.7	990.5	1,720.8
Total	213.4	922.3	1,364.7	2,451.5	4,348.8

1/ Price base: 1964 price base for agriculture, 1960 price levels for urban and other rural areas.

2/ Wyoming portion uses MRB data adusted to reflect recent population projections. Montana portion used projection coefficients from MRB study.

Source: Documentation data for Missouri River Basin (MRB) Comprehensive Framework Study.



The town of Lander had serious floods before the river channel was cleared. The threat of an occasional flood still exists.



Floods in urban areas disrupt business as well as damage property.

PLATE 22



Floods in rural areas damage roads, buildings, and cropland.



PLATE 23

IMPAIRED DRAINAGE

When the ground-water table is less than 6 feet deep, vegetation is usually affected. One effect may be a reduction in crop production. Water tolerant, saline tolerant, and phreatophytic plants may invade as other plants are drowned out. The effects vary with soil types. Water tables only 3 feet under the surface of sandy soils may have fewer adverse effects than 6-foot water tables in some clay soils. If the water table is on or very near the surface much of the time, the area becomes a marsh. While these marsh areas are of little use to agriculture, they are particularly valuable to wildlife.

Wetland areas with intermediate water table levels are of reduced value to both wildlife and agriculture. A salinity problem is often associated with these lands. Above the water table a moist capillary zone develops. The moisture in this zone fluctuates with the water table and with surface water received from irrigation or precipitation. Large amounts of water are evaporated, leaving saline solids in and on the soils. These are not leached out through downward movement of water, and the soils may become so saline that most vegetation and animal life is eliminated. It is these wet and saline lands that constitute a problem, especially when associated with agricultural lands.

In these lands the primary causes of impaired drainage are layers of soil which restrict the movement of water, excessive application of irrigation water, surface and subsurface tailwaters from higher elevation irrigated areas, and seepage from canals and ditches.

There are about 47,900 acres in Montana and 98,000 acres in Wyoming of wet and/or saline lands in the basin with water tables less than 6 feet from the surface.

Figure IV-2 is a map of impaired drainage problem areas in the basin.

WATER SHORTAGES

Agricultural

Most irrigated lands are dependent on streamflows for their water supply. However, streamflow supplies are not generally concurrent with irrigation demands. Most of the streamflow is dependent on snowmelt from higher elevations. Climatic conditions are such that the crop growing season in the lower elevations begins before high elevation snowmelt and continues after most of the snow has melted. The peak streamflow occurs as much as 10 weeks before the crops reach their peak water use rates, and streamflows recede more rapidly than use rates. The timing or temporal problem that results is illustrated in figure IV-3 which shows rather typical demand and supply curves for areas tributary to the main stem of the large streams. Some of these streams are so short of water that storing all available water and using it at near 100 percent efficiency would still not provide a full water supply for presently irrigated lands. This is because landowners have developed their lands, systems, and crops to spread

early high streamflows as far as possible, even though the crops suffer greatly reduced yields later in the season when there is little water available.

In areas where water supplies are seasonally short, increased irrigation efficiencies would increase crop production and allow the irrigation of more land later in the irrigation season. Downstream water quality would probably be improved through reduction of sediments and dissolved solids in surface and subsurface return flows. However, the net effect on the quantity of water downstream is likely to be minimal or even negative.

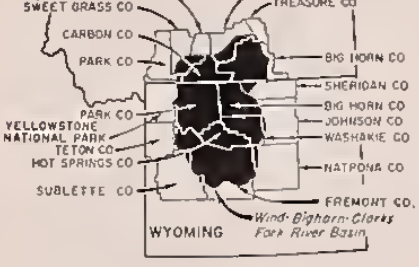
The economic incentive to increase irrigation efficiencies will be greater if supplemental late season water is suplied through storage, transfer, or ground-water development. However, storage site locations are limited in much of the area because of geologically unfavorable or other expensive conditions. Also, large water transportation projects are expensive and are limited as to potential locations. Ground-water development is limited by the availability of aquifers, their yield rates, and their quality of water.

The supply problem is less on larger streams where existing flows can generally supply the needs of presently irrigated lands. Large reservoirs such as Boysen, Buffalo Bill, and Bighorn Lake generally provide adequate seasonal supplies of water for the lands they serve. However, some water shortages still exist in these areas because of on-farm and delivery system inefficiencies and late season shortages in the very dry years. Improved irrigation efficiencies in these areas may result in significant increase in downstream water supplies, improved water quality, and increased crop production.

Table IV-5 lists water shortage problems in the basin by major subbasins in each state for 50 and 80 percent chance years. The total shortage is shown in the table as a need for stored or transferred water. These data are for presently irrigated lands at present project efficiencies. All water available and not presently diverted was considered storable, whether or not specific reservoir sites were identified. If the storable water did not supply the deficit between diversion requirements and present diversions, the remaining deficit was defined as a need for transferred water. The total area of presently irrigated land would require about 537,620 acre-feet of stored or transferred water for a full supply in an 80 percent chance year if used at present efficiencies.

Other water shortages

Probably the second most important kind of water shortage in the basin is for livestock water on rangelands. This problem is related to proper grazing management. Unherded cattle and sheep remain fairly close to water. Good grazing management requires that suitable livestock water facilities are well distributed throughout the range. About two-thirds of the rangeland in the basin needs to have more of these facilities.



LOCATION MAP

IMPAIRED DRAINAGE
(percent of irrigated land with impaired drainage problem)

- 5% – 10%
- 10% – 25%
- 25% – 50%
- Over 50%
- Water

FIGURE IV-2

IMPAIRED DRAINAGE AREAS

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-N-22441N



In order for open drainage ditches to function properly, they must receive annual maintenance to remove debris and sloughed-in banks and to be kept free from excessive vegetative growth. Two Leggins Irrigation Unit.



PLATE 24



Some land with impaired drainage is presently cropland with limited production.



Most of the land described as poorly drained is presently of little use to either agriculture or wildlife.

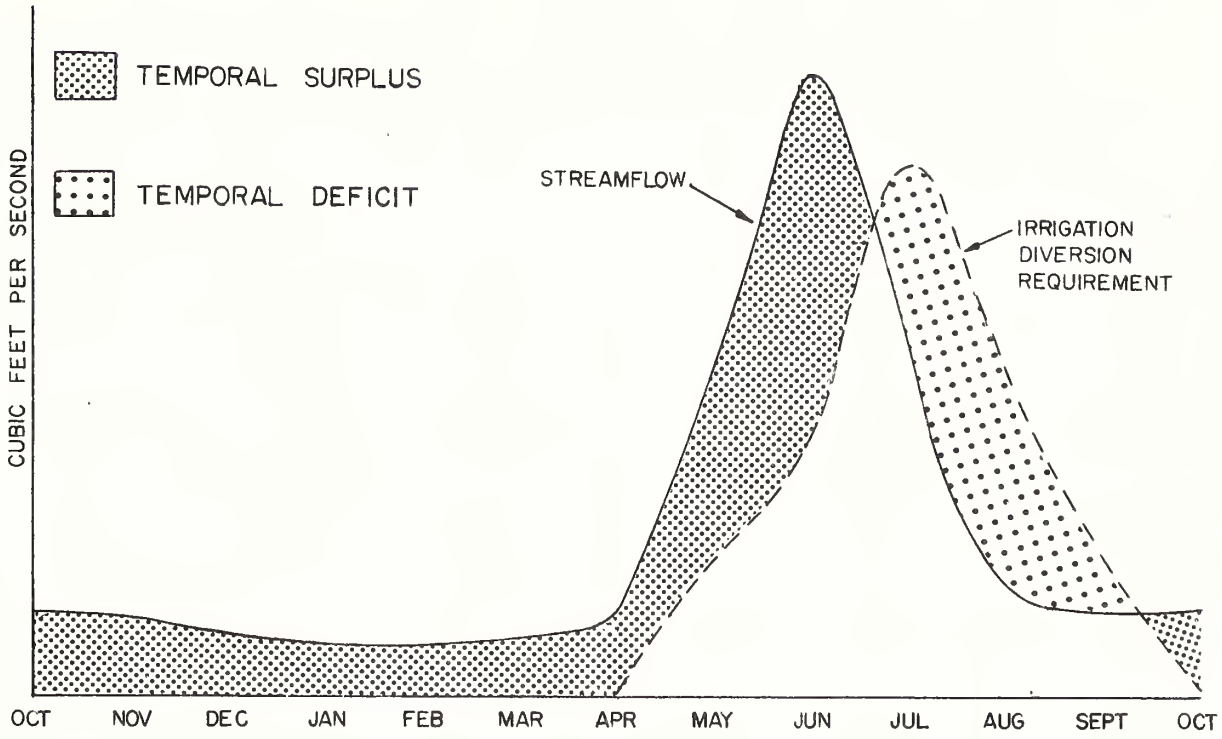


FIGURE IV-3--TYPICAL STREAMFLOW AND IRRIGATION DIVERSION REQUIREMENT CURVES

Table IV-5--Water supply shortages on presently irrigated lands with present efficiencies

Subbasin	Present area of irrigated land	Irrigation diversion requirements 1/	50 percent chance: Present water diversions	50 percent chance: Need for stored or transferred water	50 percent chance: Transfer needs 2/	80 percent chance: Present water diversions	80 percent chance: Need for stored or transferred water	80 percent chance: Transfer needs 2/
	--acres--	-acre-feet--	-acre-feet-			-acre-feet-		
Wind River	195,769	868,490	768,800	99,690	4,050	730,620	137,870	35,940
Bighorn River in Wyoming	329,503	1,747,820	1,604,700	143,120	58,800	1,531,900	215,920	138,610
Bighorn River in Montana	56,454	270,420	260,280	10,140	5,440	255,670	14,750	10,610
Subtotal for Bighorn River Subbasin	385,957	2,018,240	1,864,980	153,260	64,240	1,787,570	230,670	149,220
Little Bighorn River in Wyoming	2,441	11,890	7,770	4,120	0	7,000	4,890	0
Little Bighorn River in Montana	17,134	99,700	99,700	0	0	99,360	340	340
Subtotal for Little Bighorn River Subbasin	19,575	111,590	107,470	4,120	0	106,360	5,230	340
Clarks Fork River in Wyoming	11,119	61,230	60,230	1,000	0	59,950	1,280	0
Clarks Fork River in Montana	88,628	582,430	503,200	79,230	75,390	420,610	161,820	157,980
Subtotal for Clarks Fork River Subbasin	99,747	643,660	563,430	80,230	75,390	480,560	163,100	157,980
Stillwater River in Montana	29,252	175,110	175,110	0	0	175,110	0	0
Yellowstone Minor Drainages in Montana	39,951	253,670	252,920	750	0	252,920	750	0
Total in Wyoming	538,832	2,689,430	2,441,500	247,930	62,850	2,329,470	359,960	174,550
Total in Montana	231,419	1,381,330	1,291,210	90,120	80,830	1,203,670	177,660	168,930
Total for river basin	770,251	4,070,760	3,732,710	338,050	143,680	3,533,140	537,620	343,480

1/ Based on average annual consumptive uses and estimated existing irrigation project efficiencies.

2/ Assuming all undiverted water is storable in the local stream. Otherwise transfer needs are greater than shown here.

Another water shortage problem exists where flows in some smaller streams are too low for good fish production in late summer.

Some of the towns in the basin have facilities and water supplies too small to meet peak demands in July and August and are required to ration water for lawn and garden irrigation during these periods.

PHREATOPHYTES

Phreatophytes are plants that thrive in areas where the water tables are at or near the surface and use large amounts of water when it is available. They generally have low economic value, either because they produce little usable fiber or food products or because of their high cost to harvest. Not including the narrow strips along irrigation and drainage ditches, about 241,600 acres or 378 square miles of land are mapped as having phreatophytes. The predominant types of vegetation are sedges, rushes, greasewood, willows, and cottonwood trees. They may be considered a problem because they use about 600,800 acre-feet of water per year that might otherwise be available to improve streamflows for higher valued crops or for other purposes.

There is no notable program for phreatophyte control in the basin. Projects have been proposed to drain some phreatophyte-covered areas and convert them to agriculture. Some control projects at the local level are associated with canal and irrigation system renovation and on-farm land clearing and leveling.

Because phreatophytes have low economic value does not mean they are unimportant. Some species of phreatophytes are important habitat for big game, upland game, and small game, as well as for many other wild animals and livestock. When located on the banks of streams, they provide food, cover, and shade for fish and other aquatic species. Areas with cottonwood trees are particularly important as calving areas for range cattle, habitat for deer, and as attractive recreation areas. The Wyoming Game and Fish Commission has developed two areas of heavy phreatophyte concentration as wildlife management units. Any proposal to eliminate significantly large areas of phreatophytes must consider the total value of these areas and compare beneficial and adverse effects with those of alternative approaches.

POLLUTION

To pollute is to make something impure or unclean. The concern about pollution relates to the basic natural resources required by all living organisms--air, water, land, and food. The paradox is that every living thing pollutes these basic resources to some degree. The basic resources also pollute each other as they interact through the movement of soil, air, and water. The result is that nothing in nature is really pure, and the pollution problem is a matter of degree.

In this report we will discuss the pollution problem primarily as it relates to the water resource. Every water use has a minimum water quality requirement. Whenever the source of water fails to meet this requirement, this use is lost or made more expensive by treatment costs. Fortunately, the water quality of the surface waters of the basin can generally be described as high enough for irrigation, recreation, livestock, wildlife, and industrial uses. Most other uses require minimum treatment to remove turbidity and biological factors.

The main pollution problems are sediments and dissolved salts. The Wind River at Dubois has an average of only 105 milligrams per liter (mg/1) of dissolved salts. By the time this water leaves the basin, the concentration of dissolved salts reaches about 700 mg/1. Concentrations this high begin to have some adverse effects for irrigation, livestock, and wildlife uses. There are some small, low elevation, ephemeral streams in which dissolved salts exceed an average of 1,200 mg/1. Briny waters from some oil fields contribute to this problem.

Silvertip Creek is being polluted from the Elk Basin oil field to the extent that the Montana Animal Health Director recommends that cattle be kept from drinking the oil-laden water. The industrial practice is to provide primary oil separation treatment to these waters before releasing them. Much of this water is still used for irrigation and livestock.

Sediments in the water are particularly evident during high flows. The sediment yield to Boysen Reservoir has been serious enough to be the object of a special study.[1/] The opening of a new portion of the Riverton Reclamation Project probably accelerated the erosion of Fivemile Creek. Much of this problem has been stabilized to levels about like those of other relatively undisturbed areas of the basin. Sediment pollution damages were discussed earlier in this chapter.

Municipal and industrial waste waters in the basin generally lend themselves to treatment stabilization or full retention. A few small communities are still in need of adequate sewage treatment plants.

Mine acid pollution has been identified by the Forest Service in the headwaters of the Stillwater River and in Fisher Creek tributary of Clarks Fork River near Cooke City. Mine workings and tailings near Nye are a source of sediment and metals during periods of high runoff.

Feedlots are developing and expanding in the basin and are expected to increase in the future. Runoff and waste waters from feedlots need to be treated to prevent increased stream pollution.

Pollution from recreational facilities is generally low. This is credited to servicing of these facilities by the responsible agencies. Some activities of recreationists create pollution problems, especially

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1/ Sedimentation and delta formation in Boysen Reservoir, Wyoming, USDI, Bureau of Reclamation, October 1960.

as they promote erosion and sedimentation. Some wilderness areas have been affected by riding stock and trailriders. Some health and sanitation problems exist in these areas.

RANGE AND FOREST FIRES

Range and forest fires occur often, and there is a cyclic pattern in the occurrence of large fires. On the average about 333 fires burn over 17,900 acres in the basin each year. The majority of the fires are small and result in relatively minor damages. Large, disastrous fires occur periodically and cause significant economic and environmental damage.

Some major problems which could contribute to disastrous fires are: (1) a heavy accumulation of logging debris and slash on some areas, (2) extensive stands of overmature timber, (3) large areas of insect damaged timber, and (4) dense overcrowded stagnated stands of timber. Other factors contributing to fire problems include heavy build-up of fuel on areas long protected from fire, increased use by hunters, recreationists, and other users of forest resources, and a lack of organized fire protection for private land in some counties.

OTHER FOREST-RELATED PROBLEMS

Insect and disease damages are high on most forest types. It is estimated that up to 50 percent of the gross annual timber growth may be lost to insects and diseases. Mountain pine beetle, Douglas fir beetle, and spruce budworm are endemic in nearly all stands. Major diseases causing loss are dwarf mistletoe, commandra rust, and butt and heart rots.

Timber losses due to insects, disease, animal, and mechanical damage are significant on large areas of overmature forest. Overstory suppression is responsible for reduced growth rates on thousands of acres of established seedlings and saplings. In addition, overstocked, stagnated stands of small size timber occupy thousands of acres but produce little usable wood.

Another major problem is the lack of adequate regeneration resulting from livestock and wildlife damage, insufficient summer moisture, the large size of some non-stocked areas, and erosion of the thin, young soil. These problems are particularly severe on the Paint Creek and Pat O'Hara Creek watersheds.

Overgrazing, poor stocking of vegetation, and concentrations of noxious and poisonous plants damage rangelands and prevent full production and use of grazing resources on national forest lands.

Full use of forest recreation resources is inhibited by the lack of developed facilities and sites, or inadequate road network, insufficient trails development, uneven geographic distribution of lakes, reservoirs, and other water developments.

While there is access across some private lands to public lands, public access is blocked in many areas by private landowners who refuse to sell or grant crossings or rights-of-way to public lands. This causes overcrowding and facility problems at some existing access points and uneven recreational use of the public lands.

FISH AND WILDLIFE HABITAT PROBLEMS

Historically, loss and degradation of habitat is the primary problem related to fish and wildlife. This loss and degradation has been compensated for in part by intensive management such as winter feeding of elk in Wyoming, acquisition of land for fish and wildlife management purposes as well as for access, and construction of nesting facilities for waterfowl.

Big game

Winter habitat is the main limiting factor for big game. Decreases in winter habitat have resulted from development of minerals, highways, agriculture, recreation, and other increased human activities. Specific problem areas are described below:

a. Open pit mining and increased mineral exploration have decreased some winter habitat in the Gas Hills Mining District southeast of Lander.

b. Lack of watering facilities in the "badlands" in the central portion of the Bighorn Basin limits wildlife use of these areas.

c. Fencing throughout the basin somewhat restricts migration and distribution of big game. Overgrazing by livestock in some areas limits food for elk and deer both in summer and winter.

d. Artificial reduction of sagebrush and willow in large blocks has reduced some winter habitat for moose, deer, and antelope. The effects of big sagebrush management in any location should be carefully evaluated before being applied.

e. Moose habitat in the basin is very limited and should be carefully evaluated before developing any large reservoirs.

f. Increasing numbers of people using motorized vehicles during all seasons of the year have increased pressure on big game in some critical areas such as in the Big Horn Mountains near Shell Creek and in the Wind River Mountains near Union Pass.

Upland and small game

Intensive agriculture has affected upland and small game animals more than any other species of wildlife. A change in agricultural practices can benefit some species while adversely affecting others.

For example, cropped areas improve habitat for pheasant, quail, and rabbits, but drastically decrease habitat for sage grouse. However, some agricultural practices decrease habitat for all wildlife on agricultural lands. Lining ditches with concrete, clean farming, use of pesticides, and grazing and clearing windbreaks are examples of such practices. Sage grouse habitat is sometimes reduced because of sagebrush control and mining operations. Lack of watering facilities also affects upland and small game distribution.

Waterfowl

Waterfowl habitat is limited in the basin by lack of nesting and feeding areas.

Furbearers

Furbearers generally require heavy cover along streams. Much of this habitat has been removed through agricultural practices, road building, and other activities.

IMPAIRMENT OF NATURAL BEAUTY

Problems related to visual resource of the basin do exist. Litter seems to be a problem wherever there is human activity. Gullies and other erosion scars in otherwise well vegetated areas offend the viewer. Aesthetic values are often damaged by alteration of the natural landscape related to timber harvest, mining, transmission lines, and roads. Oil spills, waste discharges, and sediment in streams reduce the visual and olfactory quality of some landscape and water areas. Junked and abandoned cars are scattered about and are especially evident near small towns.

ECONOMIC PROBLEMS

One of the most important economic problems in the basin is the unemployment and underemployment of Indians. Part of the problem is related to land use on the reservations. About 23 percent of the land within reservation boundaries is no longer owned by the Indians. Some land went into roads, railroads, and reservoirs; but most was bought by white ranchers and farmers. Much of the best cropland and ranchland is now in non-Indian ownership, leaving more marginal land to the Indians.

A higher percentage of the total potentially irrigable land has been developed off the reservation than has been developed on the reservation. This is partially explained by the difficulties in administration of multiple ownership of small tracts of land, limited Indian development capital, early sale of good lands to whites, and differences in economic pressures confronting Indians and non-Indians. For example, division of property rights among the heirs has progressed to the point that many tracts of land now have over 100 fractional owners. Administration or legal clearance for the development of such lands is almost impossible under

present statutes. There are also some institutional and social barriers to economic development which are not discussed here, since they are beyond the scope or intent of this investigation.

Underemployment and limited specialized services are problems for nearly all of the residents of the basin. These problems, as well as the limited oppotunities for employment in the basin, are probably the reason for the high out-migration rate discussed in Chapter III.

V. PRESENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCE DEVELOPMENT

This chapter describes needs for protection, management, and development of water and land resources in the basin to solve existing problems and provide for future needs for these resources.

NEEDS FOR WATERSHED PROTECTION AND MANAGEMENT

The improved use of conservation practices, both in management and structural treatment measures, is needed to increase the productivity of the land, aid in the prevention of floods, reduce erosion, improve water quality, stabilize stream channels, and sustain streamflows.

State and private lands

There are about 9,176,220 acres [1/] of private, state, and Indian trust lands in the basin. Table V-1 lists major categories of needs for conservation practices on these lands. The first line in this table estimates areas where the present level of conservation treatment is considered adequate. This means that, where feasible, the needed structural measures are installed, management and cultural practices meet the needs of the land, and water is efficiently used. There is still a need to continue the existing level of management and to maintain structures or replace them as they wear out.

Irrigated cropland

There are about 770,250 acres of irrigated cropland in the basin. This is about 8 percent of the nonfederal land. About 52 percent of the irrigated land needs improvement in water delivery or drainage systems, water management, and cultural management.[2/] About 23 percent of this land has adequate systems, but still needs improved water management and cultural management. About 10 percent has adequate systems and water management but still needs improved cultural management.

Nonirrigated cropland

About 4 percent of the nonfederal land in the basin is nonirrigated cropland. Nearly all of this is in Montana. About 59 percent of this land needs improved cultural management.

Range and dry pastureland

About 80 percent of the private and state land in the basin is grass or brush rangeland. About 66 percent of this land needs improved conservation

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1/ Water areas and nonagricultural uses totaling about 161,550 acres not included.

2/ Cultural management includes, but is not restricted or limited to, such practices as rotation cropping, minimum tillage, stubble mulching, contour furrowing, rotation grazing, etc.

Table V-1--Conservation treatment needs on state and private lands with present land use [1/]

Treatment category	Irrigated cropland	Non-irrigated cropland	Range and dry pastureland [2/]	Non-federal forest	Other agricultural	Total
	acres					
Present treatment adequate or treatment infeasible	118,510	139,610	2,499,080	490,240	61,900	3,309,340
Cropland practices						
Irrigation and/or drainage systems	399,420					399,420
Water and cultural management	174,560					174,560
Cultural management only	77,760	209,020				286,780
Range and dry pasture practices						
Proper grazing use and planned grazing systems only			3,715,410			3,715,410
Accelerated range improvement						
Brush and weed control			1,052,630			1,052,630
Reseeding			8,480			8,480
Range renovation			36,420			36,420
Forest practices				152,030		152,030
Other land practices					41,150	41,150
Totals	770,250	348,630	7,312,020	642,270	103,050	9,176,220

Source: Conservation Needs Inventory, 1970, and U.S. Forest Service inventories

1/ Water areas and state and private lands in non-agricultural uses are not included.

2/ All irrigated pasture is included in irrigated cropland.

practices. The primary need is for improved grazing systems and management. About 14 percent of the rangeland also needs brush and weed control. Reseeding and renovation practices are needed on about 1 percent. If these lands are properly vegetated, there will be little need for structures for erosion control, and productivity will increase.

The need for improved grazing practices is closely related to the need for additional stockwater facilities described later in this chapter.

Nonfederal forest land

About 7 percent of the state and private lands are forest lands. A large portion is on the two Indian reservations and is expected to be managed to remain in a natural or roadless state. About 24 percent of all nonfederal forest lands need improved timber and grazing management practices.

As recreation use increases, there will be a need to increase fire prevention and protection measures, improve roads and trails, provide adequate sewage and garbage facilities, prevent overuse of recreation sites, and control off-road vehicular travel. Mining operations must be controlled to minimize damage to aesthetic values and prevent erosion. There is also a need to rehabilitate abadoned mined areas.

Other agricultural lands

These are farmsteads, lanes, ditches, and the like. About two-thirds of these lands need some conservation practice, primarily revegetation.

Federal forest and rangeland

Table V-2 lists forest and rangeland development needs in the basin, and specific items are discussed below. Projections of economic activity for the nation, region, and basin show a need to increase timber production. In order to meet expected demands the supply of timber available for harvesting needs to be increased 12 percent in 1980, 31 percent in 2000, and 39 percent in 2020.

Planting or seeding is needed to reforest or regenerate about 8,800 acres of forest land. This will reduce accelerated erosion and sediment production, improve hydrologic conditions, and contribute to long-range satisfaction of timber needs.

About 127,800 acres of forest stands need to be harvested and regenerated or given salvage and sanitation cuts. This will solve problems of decadence and excessive losses from insects and diseases on these areas. Timber supplies can be significantly increased, and grazing and wildlife resources can be improved.

Thinning, weeding, release cutting, pruning, and other cultural treatments are needed to reduce fuel accumulations, improve growth, and combat insects and diseases on 196,600 acres.

Table V-2--Federal forest and rangeland development needs, Wind-Bighorn-Clarks Fork River Basin, Wyoming and Montana

Development need	Unit	National forest	Public domain
Range revegetation Plant control, type conversion	acres	36,600	37,300 1/
Range distribution trails	miles	190	350 1/
Range fences	miles	695	1,000 1/
Range water developments	each	363	2,010 1/
Timber management: Planting or seeding	acres	6,778	2,000 1/
Insect control	acres	51,600	5,000 1/
Disease control	acres	140,000	0 1/
Release, harvest, thin and weed	acres	127,800	0 1/
Fishing stream improvement	miles	820	N/A
Fishing lake improvement	acres	4,750	N/A
Wildlife habitat management	acres	11,700	N/A
Fence key wildlife areas	miles	60	N/A
Trail, construction, and improvement	miles	1,840	N/A
Road construction and improvement	miles	1,910	N/A
Roadside observation sites	each	48	N/A
Erosion control for:			
Gullies	miles	125	N/A
Sheet erosion	acres	4,100	N/A
Abandoned roads and trails	miles	270	N/A
Streambank stabilization	miles	30	N/A
Mining control and restoration	acres	85	N/A
Snowpack management, alpine	miles	65	N/A
Recreation site improvement	acres	1,163	N/A

1/ Treatment planned - total needs are not known.

Range seeding, proper herding and distribution, control of noxious and poisonous plants, stockwater developments, and range fencing are needed to improve forage and meet demands for forest land grazing. Type conversion, plant control, and revegetation are needed on about 73,900 acres. About 1,695 miles of fencing to control grazing, 2,373 stock reservoirs, and 540 miles of stock distribution trails are needed.

There is a need for restoration and habitat improvement on 820 miles of streams and 4,750 acres of lakes on national forest land. About 30 miles of streams need treatment to stabilize banks and reduce sediment loads.

Management needs for terrestrial wildlife habitat include wildlife openings and food patches, thinning of dense, stagnated timber stands, openings and trailways in timber, and cover strips in cleared forest areas. On national forest land about 11,700 acres of wildlife habitat restoration and improvement and 60 miles of fencing are needed. Special management and protection is needed to sustain serveral rare and endangered species.

Fire prevention and control measures are needed to reduce the number, size, and intensity of range and forest fires. Some of these needs are reduction of fuel and logging debris, salvage of insect damaged stands, improved fire detection, additional fire weather stations, intensification of aerial fire control, prescribed burning where beneficial, increased study of fire control by weather modification, hazard reduction along roads and trails, and improved coordination between suppression agencies.

Roads, trails, mines and excavations, overgrazed areas, and areas damaged by off-road travel need erosion control measures, revegetation and hydrologic improvement. On national forest land sheet erosion control is needed on 4,100 acres, 125 miles of gullies need control, 270 miles of eroding roads and trails need rehabilitation, and 85 acres of eroding mine areas need treatment.

There is a need for additional development of recreation sites to alleviate seasonal overuse and deterioration of sites and to satisfy projected recreation demands.

An adequate system of roads and trails is needed to develop, manage, and protect forest resources. Construction and reconstruction is needed on about 1,910 miles of forest roads. Included is a network of low-speed high standard scenic roads with more than 48 scenic observation sites. About 1,840 miles of recreation trails are needed for backpack hiking, horseback riding, trail bike and snowmobile use, and walking for pleasure.

NEEDS FOR FLOOD PREVENTION AND SEDIMENT CONTROL

Floods are a problem in the basin though damages in the past have been limited because of sparse population and intelligent location of most

residences out of the floodplains. Future damages will be greater unless floods are reduced and development in floodplains is severely restricted. The most urgent needs for additional floodwater and sediment control are for communities and rural residences on Little Popo Agie River, Nowood River, Lodge Grass Creek, Blue Creek, Little Bighorn River, Pryor Creek, and Stillwater River. Protection for agriculture is needed on Crow Creek, Beaver Creek, Badwater Creek, Little Popo Agie River, Nowood River, Greybull River, Shell Creek, Shoshone River, Lodge Grass Creek, Blue Creek, and Little Bighorn River.

The primary need is to prevent the construction of buildings or residences within the 100 year floodplains. There is also a need to develop flood prevention storage in upstream reservoirs or levees to protect existing developments and agricultural land. Some existing buildings need to be removed from the floodplains of Blue Creek, Pryor Creek, Little Bighorn River, Rock Creek, and the Stillwater River and its tributaries. These buildings not only receive frequent damage but endanger other properties by reducing channel capacities.

GULLY AND STREAMBANK STABILIZATION NEEDS

The watersheds inventory in the 1970 conservation needs inventory lists about 95,000 acres with significant erosion damage in this basin. Most of this area is associated with unstable channels. Structural practices needed to reduce this damage include diversions, terraces, grade stabilization structures, debris basins, channel stabilization, streambank protection, clearing and snagging, improved diversion dams, drop structures for irrigation return flows, and flood retarding dams. Streambank revegetation and grassed waterways and other vegetation related practices are also needed.

When applied, conservation practices listed in table V-1 which reduce sheet and rill erosion will also help reduce gully and streambank erosion. They reduce surface runoff rates, thus reducing erosive energy in the basin's streams. Artificial as well as natural channels need to be stabilized. One of the most critical of these is the Enterprise Ditch near Lander.

DRAINAGE IMPROVEMENT NEEDS

There are about 145,900 acres of poorly drained croplands in the basin. The high water table problems need to be reduced through improved irrigation water management, lining of canals to reduce seepage, and the installation of open and closed drains if this land is to be used efficiently. Drainage of these lands will allow increased grain production and generally benefit waterfowl and upland game. Many existing drains need rehabilitation or replacement. Additional drainage will be needed if new lands are irrigated. For the most part, these lands should not be confused with wetlands which are important to wildlife.



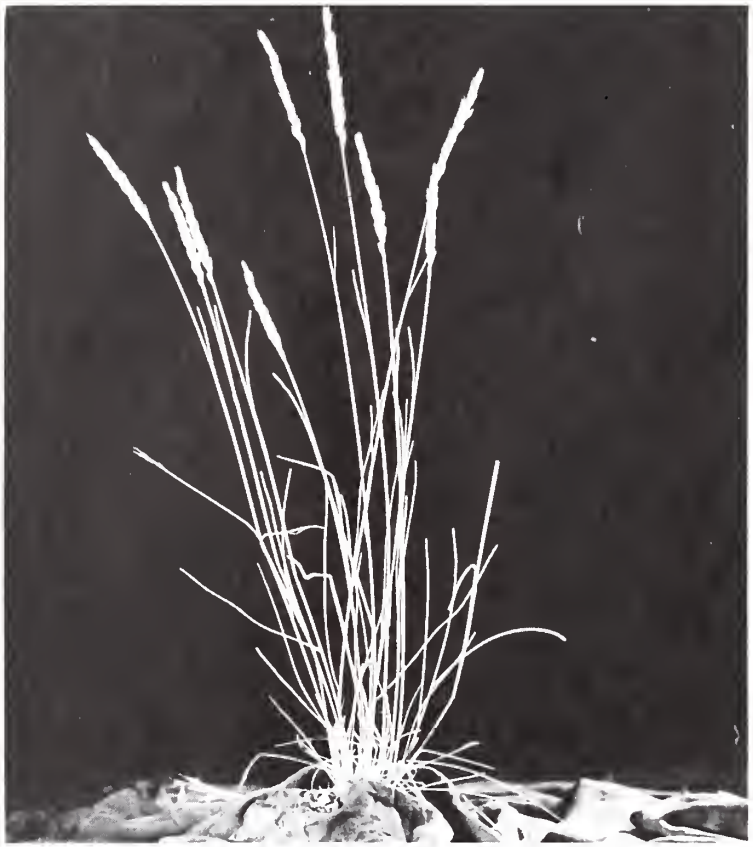
Among the important conservation needs in the basin are improved irrigation water delivery structures, tailwater recovery structures, and improved water management on the fields.







PLATE 26



Rhizomatous wheatgrasses are native to rangelands in the basin. Good healthy grasses are food for livestock and wildlife and cover for birds and other small animals. Grasses improve soil structure, prevent soil erosion, and increase soil moisture by reducing losses of snow and rainfall.



About 80 percent of the private and state land in the basin is rangeland. The primary range conservation need is improved grazing systems and management.



About 14 percent of the rangeland needs brush management and weed control.

Grass for livestock is not enough. Wildlife habitat needs must be properly considered.





A well-balanced plant community is needed to provide for a variety of life.

PLATE 28



There wasn't enough water to provide a second irrigation. Both supplemental water supplies and improved irrigation efficiencies are needed.



Only about one-third of the livestock water supplies needed to improve range use have been developed.

NEEDS FOR IRRIGATION WATER

Agriculture is and probably will continue to be one of the most important sectors of the basin's economy. Some of the economic and social problems discussed earlier, such as underemployment, low per capita income, and extensive out-migration are related to agriculture. These problems may be alleviated by increasing farm incomes and agricultural crop production.

Currently, about two-thirds of the value of agricultural production comes from irrigated lands. Where the water available to these lands is less than its potential consumptive use, an increase of water supply will increase production.

Better efficiencies can provide some of this water without increasing diversions from the supply streams. Improved irrigation systems and improved management of irrigation water are needed to reduce tailwater, deep percolation, evaporation, and improve the uniformity of water distribution on the field.

Increased efficiency has the least effect on production (and on downstream annual water supplies) on the smaller stream where water supplies are shortest and where present field irrigation efficiencies appear to be the lowest. This is because the main limitation is a severe shortage of water in the supply streams during the peak growing months of July and August. These areas need additional late season water supplies from storage reservoirs, wells, or intrabasin transfers of water if production is to be significantly increased. Only when these supplemental supplies are provided will the benefits exceed the costs of providing improved systems and management in these areas.

There are about 770,250 acres of irrigated land in the basin. About 329,000 of these are in watersheds which are short of a full and reliable water supply. These watersheds will need about 537,620 acre-feet of supplemental water annually in dry years. See table IV-5 for a breakdown of these shortages by subbasins.

As shown in table III-10, irrigated land is expected to increase from 770,250 acres at present to 857,100 acres by 2020. This is an increase of 86,850 acres. This new land use will require about 180,000 acre-feet of water per year for consumptive use requirements. If this water is used at an average 50 percent overall efficiency, this will be a 360,000 acre-feet water requirement.

NEEDS FOR RURAL, DOMESTIC, AND LIVESTOCK WATER

The primary need for livestock water is related to the need for improved range management. As a rule of thumb there should be a livestock watering facility in each square mile of rangeland to promote even distribution of grazing pressure. Surface water in streams, ponds, and springs

is not sufficiently distributed to provide the needed supply. Only about one-third of such needed supplies has been developed in the basin. To achieve the proper range improvement, more wells, spring developments, drift fences, and ponds need to be developed.

Potable water for human consumption on farms and ranches is supplied largely by wells. Some of this supply is poor in quality because of high salts content. Residents between Yellowtail Dam and Hardin, Montana, have been exploring the feasibility of a water treatment plant and pipeline system to serve their farms. The residents near Fromberg also need improved water supplies.

NEEDS FOR MUNICIPAL AND INDUSTRIAL WATER

At present there is generally an adequate water supply for the towns in the basin and for existing industry. Some towns have a need to enlarge and improve their water supply systems to replace old systems or to serve population expansion.

Water needs of new industry, developing outside the basin, will likely have a major impact on future water development in the basin. Coal deposits in northeastern Wyoming and eastern Montana are expected to become a major energy source in the near future. The development of energy from coal in modern plants requires large amounts of water. The Bighorn River is the nearest source of large quantities of available water. Industrial companies have already indicated an interest by purchasing options from the Bureau of Reclamation to use this water when a project is developed to transport the water to the coal fields.

RECREATION NEEDS

Recreation is an important use of water and related land resources in the basin and the surrounding area. Yellowstone and Grand Teton National Parks, Yellowtail Dam and Big Horn Canyon National Recreation Area, Custer Battlefield National Monument, Reno-Benteen Battlefield Memorial, and several Wilderness and Primitive Areas are located in or adjacent to the basin. Many tourists and recreationists travel to or through the basin while enroute to these well-known attractions. A major part of the recreation activity occurs on public lands.

In the Wyoming portion of the basin there are four state parks covering an area of 55,500 acres of land and water. Hot Springs State Park near Thermopolis contains one of the world's largest mineral springs and one of the few remaining buffalo herds. Sinks Canyon State Park, Boysen State Park near Shoshoni, and Buffalo Bill State Park near Cody surround large reservoirs, each containing several thousand surface acres. Chief Plenty Coups Memorial State Monument is in Montana, and Pompeys Pillar is a registered national historic landmark. Dude ranches, resorts, historic places, and municipal parks also provide recreation opportunities.

Recreation needs in the basin are a function of both local and national forces. However, the latter will become increasingly more important in the future. Along with increases in population, vacation and leisure time, and per capita income, there will be associated increases in recreational pursuits. The Wind-Bighorn-Clarks Fork Basin will have to absorb some of this pressure.

Total recreational use is projected to increase from 6,512,200 visitor days in 1970 to 13,489,100 visitor days in 2020, an increase of 107 percent. This increase is a function of increases in both resident and nonresident populations. Projections of use may be low because additional population increases associated with coal strip mining to the east of the basin were not considered.

In this report, all levels of recreation activity are expressed in visitor days where one visitor day equals 12 hours of recreation participation. This measure does not necessarily indicate the number of times a particular activity is enjoyed; for example, it is assumed that one visitor day of picnicking represents six persons having one 2-hour picnic or one person having four 3-hour picnics. However, one picnic table is occupied for each picnic, and a picnic table might be used only once (probably 2 to 4 hours) during a day and perhaps no more than twice. Each visitor day may represent more than one recreational experience. More than one-half of the total annual use occurs during peak periods associated with weekends and holidays.

There is a demand for more and better outdoor recreational facilities in the basin even though the reported capacity of existing facilities exceeds the reported use. Camping facilities in the basin are not now adequate for peak period demands although some campgrounds are not completely filled even during peak periods. The need is for additional and improved facilities in high use locations.

Private lands near public lands may provide the best opportunity to develop additional recreation facilities since private businesses are permitted to determine economic feasibility of development. This is likely to be the only way in which additional recreational facilities can be provided, since public construction funds for this purpose are limited. Public monies might be used to provide better access to public lands and improved public information. Facilities provided through the investment of nonpublic funds will more closely approximate the demand for recreation, since private entrepreneurs tend to develop resources only to the extent that the recreationists will pay for its use. In addition, emphasizing facility development on private lands while investing public recreational funds in supporting services will minimize competition between these sectors. Other factors which may affect recreational use on private lands include national park policies to reduce and eventually eliminate camping facilities and the further restriction of vehicular travel to designated roads and trails on public domain and national forest lands.

As the use and development of recreation areas increase, there will be a greater need to control the location and distribution of facilities and recreation demand. This may require city and county zoning laws, additional information concerning use-density relationships, price incentives to shift the recreation demand more to midweek, and improved design and maintenance of recreation facilities.

FISH AND WILDLIFE NEEDS

The projected needs for development of recreation facilities also point up the growing demand for fishing. Storage of water in reservoirs to maintain or augment flows in trout streams or to provide permanent storage for fish and wildlife should be considered wherever financial sponsors can be found to pay for the nonfederal share of costs for these purposes. Benefits to fish and wildlife from erosion and sediment reduction by land treatment and structural practices need to be encouraged and publicized.

The demand for hunting opportunities for both residents and nonresidents is expected to increase. Population increases and changes in per capita income will influence the amount of hunting opportunities desired. The capacity to increase the supply of game species is dependent upon the quality and quantity of habitat available. Acquisition and management of additional habitat will be needed if game populations are to be maintained or expanded. Improved habitat for game animals should provide an increase in population of other desirable species as well.

When projects are developed, care should be taken so that habitat areas near the project site are not seriously degraded. Interagency cooperation leads to better use of available fish and wildlife resources and provides for increased benefits. Special emphasis needs to be placed on developing wildlife habitat near population centers and along tourist routes.

NEEDS FOR WATER QUALITY CONTROL

At 620 to 695 milligrams per liter, the dissolved solids content of the water in the Bighorn River is approaching the recommended upper limit of domestic and livestock water use. There is a need to pursue programs which will prevent any further degradation of water quality. Water quality needs to be protected by treating feedlot wastes, reducing erosion, and other similar actions. Increased recreational use will require more facilities and better management to control pollution from human and animal wastes. Increased use of fertilizers wll increase the need to reduce surface runoff from irrigated areas. Accelerated enforcement of water quality laws will be needed as the potential for pollution increases.

NEEDS TO PROTECT NATURAL BEAUTY

There is a growing need to provide for the aesthetic as well as the economic and utility needs of water and land resource development projects. These needs include reclamation of strip-mined areas, regeneration of timber harvest areas, roadside plantings, and design of water storage and diversion structures to complement the natural surroundings. The need is not only to develop an awareness for the quality of visual resources, but also to utilize the skills of landscape architects, ecologists, and engineers in designing projects, related structures, and other land resource development projects to optimize the combination of outputs.

RURAL POWER SUPPLY NEEDS

Electricity to rural areas is supplied primarily by rural electric cooperatives. New power supplies and transmission facilities will be needed, as demands for power are expected to double or triple by the year 2020. Many of the new hookups will be rural nonfarm residences, summer homes, and small industries.

VI. EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

Many state and federal programs and projects provide technical services and financial assistance for resource management and development needs in the basin. The public should be well informed of the services and assistance available and how they can be utilized. This chapter lists some administering agencies and briefly describes their current programs.

USDA PROJECTS AND PROGRAMS

Soil Conservation Service

The Soil Conservation Service (SCS) assists conservation districts in giving technical assistance to individuals, groups, organizations, towns, cities, counties, and state governments in reducing costly waste of land and water resources and in using them according to their capabilities. This is accomplished through unified planning that combines all the technologies, considers all the resources, and recognizes the human interests that apply to each area of land and water use. The major SCS programs available to residents of the basin are described below:

Assistance to landowners

The SCS has a basic continuing program of providing technical assistance in the conservation of land, water, and related resources as requested by landowners and entities of state and local government which have planning authority. Conservation districts provide local direction, leadership, and coordination of this program. Conservation district programs are available for the entire basin. The services available include assistance in farm and ranch planning, field services for installation of conservation practices, soil surveys, plant materials improvements, snow surveys, water supply forecasts, technical assistance for agricultural water management, and other such services.

Under the Great Plains Program, available in some northern portions of the basin, the SCS also provides cost-sharing under contracts for water and land conservation measures for cooperating landowners. Part of a Great Plains agreement includes long-range continued planning for each farm or ranch.

Conservation practices installed in the basin with SCS assistance include irrigation ditch improvements, land leveling, irrigation management systems, stubble mulching, stripcropping, chiseling and subsoiling, stock ponds, spring and well developments, fish ponds, grazing management systems, fencing, brush management, and wildlife cover plantings. Advice is provided for erosion control connected with new construction of homes and highways. Technical assistance is provided for rural sewage disposal and pollution prevention measures for homes and feedlots. Soils, hydrological, and geological interpretation assistance are provided for rural town sewage disposal systems.

Watershed protection and flood prevention projects

The SCS provides technical and cost-sharing assistance in project type undertakings to qualified local sponsoring organizations in planning, designing, and installing land treatment measures and structural works of improvement to reduce floodwater, erosion, and sediment damages and to promote other water and related land management and development practices. Applications for assistance are submitted to the Secretary of Agriculture through the Governor or his designated state agencies and the State Conservationists of the SCS.

There is one existing watershed project in the basin. This is the Candy Jack Watershed Flood Protection Project in and near the town of Thermopolis. About 4,000 feet of large diameter pipe have been installed to protect about 100 homes and 10 businesses on about 400 acres from frequent flooding.

There is one active watershed application in the basin. The application for Two Leggins Canal in Montana is awaiting preliminary investigation. There are several inactive applications for watershed projects in the basin.

Resource conservation and development projects

The SCS is responsible for coordination of U.S. Department of Agriculture RC&D activities and provides technical and financial assistance to locally sponsored RC&D projects. The objective is to expand socio-economic opportunities for the people of an area by assisting them in developing and carrying out plans of action for the orderly conservation, improvement, development, and wise use of their natural resources.

Applications for projects are submitted to the Secretary of Agriculture through the Governor or his authorized agency and the State Conservationist of the SCS. When a project is authorized for planning assistance, a coordinator is appointed who assists local sponsors in developing a plan. This takes from 6 months to a year or more. Most projects have citizen and advisory committees for agriculture, forestry, water resources, business and industry, transportation, health, education, recreation and wildlife, and community facilities. Policies and priorities are set by a steering committee or executive council composed of the representatives from the sponsoring local units of government. The project then becomes eligible for technical and financial assistance in project measures.

The Bighorn Basin RC&D Project for Big Horn, Fremont, Hot Springs, Park, and Washakie Counties (which include most of the Wyoming portion of this river basin) is operational. The Beartooth Resource Conservation and Development Project serves all of Carbon and Stillwater Counties in Montana.

U.S. Forest Service

The U.S. Forest Service provides technical assistance to state and private owners through cooperative agreements with the State Forester.

It also administers national forest lands under the multiple use concept to provide forest products, recreation, forage, and watershed protection. Specific programs are as follows:

Cooperative state-federal forestry programs

The Forest Service and the State Foresters cooperate in a number of programs in the basin designed to promote better management and protection of state and private forest land. The cooperative forestry programs are administered through the State Foresters of Wyoming and Montana.

Foresters assist each county or state district in making wildfire plans, obtaining equipment, organizing and training fire suppression forces. Suppression of fires is performed primarily by the counties, and technical assistance is furnished by the State Forester. Some progress is being made in providing adequate fire protection for the private, state, and other nonfederal land in the basin under the cooperative protection program. Only about half of the private land in the Wyoming portion of the basin is covered by cooperative fire control agreements.

Through the cooperative forest management program, the federal government shares with the states the cost of assisting private woodland owners, loggers, and processors of forest products. The program provides technical guidance in the multiple-use management of woodland resources.

The cooperative forest management program is growing, gaining support, and is needed to improve the marketing and utilization of forest products and increase the productivity of private forested lands.

The major program utilized in the basin is cooperative distribution of planting stock under provisions of section IV of the Clarke-McNary Act of 1924. Under this program, private landowners may obtain tree seedlings from their State Forest Service in Montana and from the University of Wyoming through county agents in Wyoming for windbreaks, shelterbelts, and forest plantings.

Authority to enter into cooperative agreement with the states is provided by the Federal Pest Control Act of 1947. The State Forester is responsible for detection, evaluation, and control of insect and disease problems on private and state forest land.

National forest development and multiple use programs (Early Action)

National forest watershed management includes coordination of all other forest resource uses to maintain and improve watershed conditions. Planned measures benefiting watersheds include range revegetation and type conversion on 14,600 acres, 5 miles of gully control, 388 miles of range fence to protect problem areas and newly established vegetation, and reforestation and afforestation of 5,778 acres (table VI-1). In addition, thinning, releasing, and weeding planned primarily to benefit timber resources can have a secondary effect of increasing water quantity by reducing evapotranspiration.

Table VI-1--Land treatment and structural measures currently planned under existing programs for the national forest lands in the Wind-Bighorn-Clarks Fork River Basin

Item	Amount	Unit
Range revegetation - plant control and type conversion	14,600	acres
Range management - stock distribution trails	160	miles
Range management - fencing	388	miles
Range management - stock water developments	261	each
Reforestation and afforestation - planting and seeding	5,778	acres
Timber management - release weeding, thinning, and pruning	23,100	acres
Fish habitat improvement - streams	410	miles
Fish habitat improvement - lakes	1,160	acres
Wildlife habitat management - establish forage plants and release wildlife food plants	30	acres
Wildlife habitat restoration and development - protect key areas by fencing	3	miles
Trail construction and improvement	1,440	miles
Road construction and improvement	1,560	miles
Roadside observation sites	10	each
Road, trail, and stock driveway bridges	51	each
Erosion control - gullies	5	miles

Timber is an important product of the national forests; and, as projections in chapter III indicate, increasing demands are expected in the future. Timber management activities planned under existing programs include up-to-date inventories on all national forest lands, better timber sale preparation and administration, reduction of insect and disease losses, improved utilization of available timber, reduction of fire losses, continued research to improve genetic characteristics of trees, and provide better silvicultural practices (table VI-1). More specific activities include constructing 1,560 miles of roads and 5' bridges; releasing, weeding, thinning, and pruning on 23,100 acres; and reforestation and afforestation on 5,778 acres. Achievement of these planning goals



The SCS assists conservation districts by providing technical assistance to landowners.

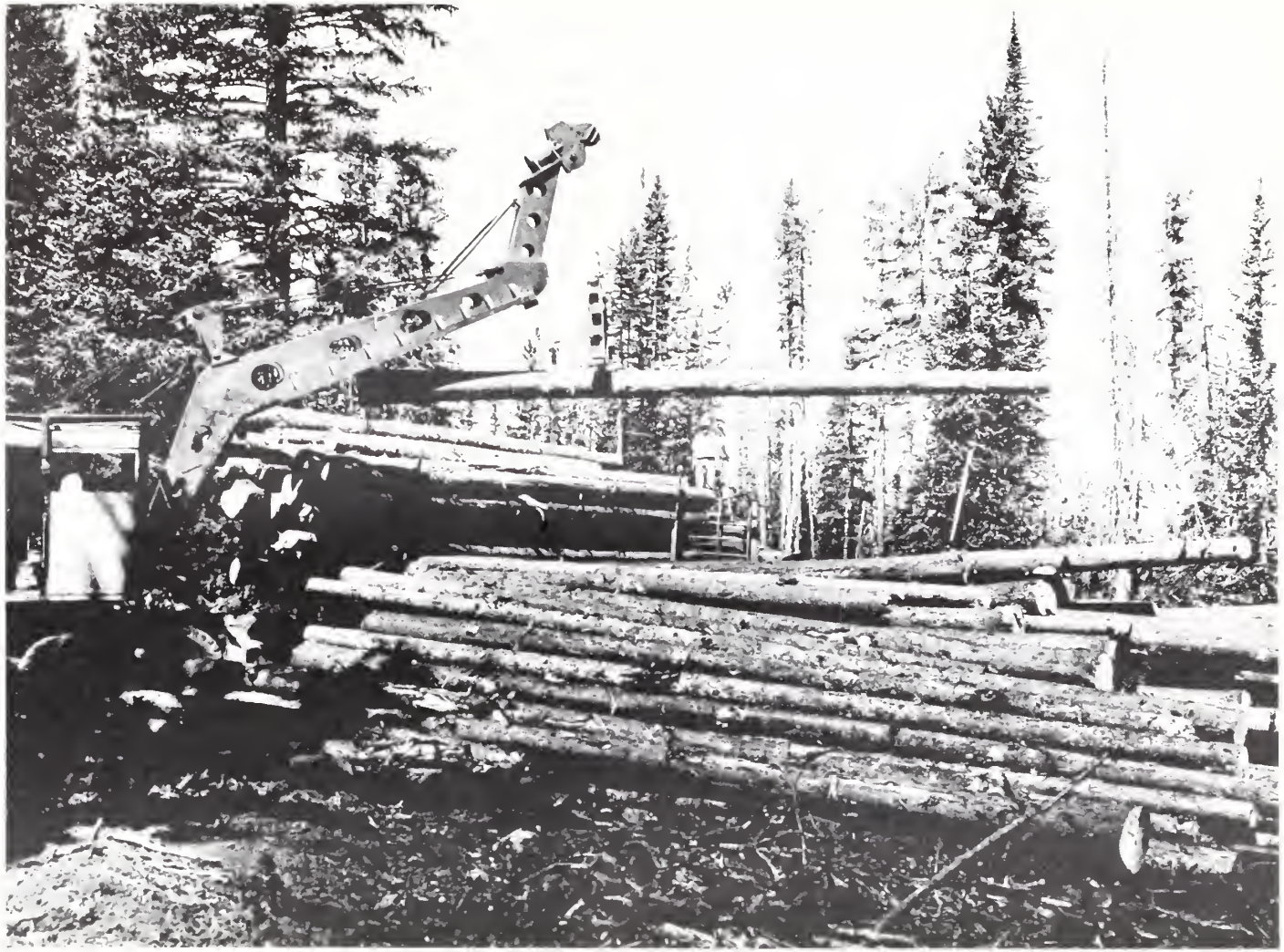
A large diameter pipeline now provides flood control for the Candy Jack Watershed.





The Recreation and Tourism Committee meets to help develop the Bighorn Basin RC&D plan.

PLATE 31



Timber harvest management is just one of the activities of the U. S. Forest Service.

U.S. FOREST SERVICE PHOTO

in the next 10 to 15 years will have some effect on timber supplies in the 1980-1990 period, but most will come in 2000 to 2020 and beyond.

The development and management activities planned under existing range resource programs are: complete allotment inventories and management plans for all national forest land; revegetation, plant control, and type conversion on 14,600 acres; and construction of 388 miles of range fence, 160 miles of stock distribution trails, and 261 stockwater developments.

Most of the outstanding natural attractions and potential outdoor recreation areas are in the national forests. It is the objective of the Forest Service to develop and manage the recreation resources to meet the demand in terms of kind, quantity, and quality. Current Forest Service policies and programs are adequate to supply projected demand for outdoor recreation sites for most land-based activities through 2000.[1/] Some planned measures are 1,440 miles of trail construction and improvement, 1,560 miles of road construction and improvement mentioned previously, and 10 roadside observation sites, vista points, and scenic turnouts.

Wildlife and fish resources attract many visitors, and this use is expected to increase. The resources are considered adequate to meet current demands in spite of reductions in the amount and quality of habitat. The Forest Service program is designed to enhance wildlife and fishery resources, improve lowered quality, and mitigate losses from development and land use changes.

Measures planned for the next 10 to 15 years include about 400 miles of stream habitat improvement, lake habitat improvement on 1,150 acres, establishment and release of wildlife forage plants on 30 acres, and 3 miles of fencing to protect key wildlife areas. The watershed programs which reduce erosion and sediment will have a favorable effect on fisheries as water quality is improved or maintained.

Fire control within the national forest boundary is the responsibility of the Forest Service. Forest fire control on private and state timber lands is the responsibility of local fire districts in cooperation with the State Forester in Montana and the counties and the State Forester in Wyoming. Range fires on the public domain are controlled by the Bureau of Land Management. Cooperation between agencies occurs where lands of various ownerships are threatened.

Economic Research Service

The Economic Research Service conducts national and regional programs of research, planning and technical consultation, and services pertaining to economic and institutional factors and policies which relate to the use, conservation, development, management, and control of natural resources.

1/ Some of these programs and policies relate to the development of recreational facilities on private lands.

This includes estimating the extent, geographic distribution, productivity, quality, and the contribution of natural resources to regional and national economic activity and growth. Also included are: resource requirements, development potentials and resource investment economics, impact of technological and economic change on the utilization of natural resources, resource income distribution and valuation, and the recreational use of resources. The agency also participates in departmental and interagency efforts to formulate policies, plans, and programs for the use, preservation, and development of natural resources.

Farmers Home Administration

The Farmers Home Administration serves as the lending agency for a wide variety of loan programs ranging from annual production loans through farm purchase loans to watershed project financing. SCS cooperates with FHA by providing the technical planning information to support loan applications for developments that deal with soil and water conservation measures.

Cooperative Extension Service

The Extension Service is a part of the Cooperative Extension Service partnership. Federal, state, and county governments share in financing, planning, and carrying out information and educational programs. The Extension Service acts as the educational agency of the U.S. Department of Agriculture. Extension specialists and county agents cooperate with other agencies to provide local information relating to conservation programs, weed control, crop culture, animal culture, herbicides, pesticide fertilizers, homemaking, and other types of information and assistance.

The Extension Service has the organizational leadership in the Community Rural Development (CRD) Program which assists rural people in identifying the services they need for economic, social, and cultural growth and helps them secure those services.

Rural Electrification Administration

The Rural Electrification Administration has provided loans for construction of rural electric association cooperative facilities, transmission lines, and rural telephone systems throughout the basin where such utilities were not available. Additional loans were available for farm electrification and household appliances.

STATE PROJECTS AND PROGRAMS

The State Engineer is responsible for the supervision of Wyoming's water resources and is concerned with water resource planning in the state. The Wyoming Water Planning Program under his direction has developed the Wyoming Framework Water Plan.

The Wyoming Department of Economic Planning and Development is charged with the conservation and development of the water resources of the state. This includes conducting studies and other activities in connection with investigation, financing, and construction of proposed water resource projects.

The Wyoming Game and Fish Department, in addition to its fee lands, manages various wildlife management units through various agreements with federal land administering agencies (table II-2, page II-8). These units provide winter range for big game animals, upland game and waterfowl habitat, fish rearing facilities, and public access for hunting and fishing. The Department also cooperates with USDA agencies in providing technical assistance to landowners who want to improve fish and wildlife habitat. A regular and successful program of the Department is to provide public access areas for water-based hunting and fishing.

The Wyoming Recreation Commission administers Boysen and Buffalo Bill State Parks. These are located on the reservoirs of the same names in Wyoming. It also provides and administers several monuments and information sites in the basin. An important new program provides facilities for snowmobile users.

The Montana Department of Natural Resources in cooperation with the Fish and Game Department operates Cooney Reservoir for irrigation and recreation. The total storage at Cooney is 27,515 acre-feet, of which 24,000 acre-feet are used for supplemental irrigation. This was the first "Water Board" project in Montana. The Department also has a state water planning program, rangeland resource program, and a forestry resource program.

The Montana Fish and Game Department has developed facilities at Cooney Reservoir and fishing access sites along Rock Creek, Stillwater River, Bighorn River, and Bluewater Creek. There is a fish hatchery on Bluewater Creek.

The Wyoming State Department of Agriculture works with farmers, ranchers, and agriculture based businesses in the state to assist them in meeting the needs of the present and future, to improve the economy, and to maintain the high quality of food products. Divisions of the Department administer weed and pest control, weights and measures inspection, food quality inspection, animal and plant disease control, research, information, planning, and development programs.

The Wyoming State Forestry Division is currently participating in the Bighorn Basin RC&D Project and has several forestry resource cooperative programs in the area. Cooperative agreements between the Division, the U.S. Forest Service, and Big Horn, Park, and Washakie Counties have been made for land use development, protection, planning, and coordination.

These and other state agency programs are described in more detail in corresponding chapters of the State Supplements to this report.

PROJECTS AND PROGRAMS OF OTHER FEDERAL AGENCIES

Bureau of Indian Affairs

The Bureau of Indian Affairs (BIA) provides technical assistance and social services to Indians on the Crow and Wind River Indian Reservations. The special programs for Indian citizens are related to the administration of trust lands and water rights. Indian reservation lands comprise over 18 percent of the total area of the basin. The limits of Indian water rights are presently undefined and very controversial.

Indian claims to the use of water are predicated upon principles set forth in the Winters vs. U. S., a 1908 Supreme Court case, which held that there is an implied reservation of rights to use water by and for the Indians in the springs, streams, lakes, or other sources of water which arise upon, border, or traverse their lands. These claims remain indefinite in the amount of water to be owned or used by or for the Indians, and several court cases and legislative bills are pending action. The determination of the limits of these rights may have a significant impact on the development of water resources in the basin.

Irrigation development by the BIA on the Crow Indian Reservation started with the Reno Unit in 1885. This was followed by the Soap Creek Unit in 1894 and other units in later years for a total of 11 units under the Crow Irrigation Project. The largest of these units is the Bighorn Canal Unit with 21,800 acres irrigated. Total land irrigated in Big Horn County amounts to 63,058 acres, including the private development of 14,100 acres under the Two Leggins Canal. All development is from direct diversion except for offstream storage in the Willow Creek Reservoir near Lodge Grass.

There are a number of ditches and canals on the Wind River Indian Reservation. Perhaps the most significant is the Dinwoody Canal. Nearly 39,000 acres on this reservation are irrigated from projects developed through federal assistance.

Considerable work on range utilization improvement is under way with development of springs, wells, and pipelines for stockwater supplies and grazing dispersal. A recreation complex and a carpet factory have been developed at Crow Agency to improve employment opportunities. The Pretty Eagle recreation development near the north end of the Bighorn Recreational Area is nearing completion and will add to employment opportunities.

Bureau of Reclamation

About 211,200 acres of cropland have been or are being developed in the basin through reclamation projects. The existing projects are listed below:

a. Owl Creek Unit

This is a project which includes a storage dam and pumping facilities to ultimately provide supplemental water to 13,123 acres of irrigated land. Water is presently pumped from the Bighorn River to supplement the supply obtained from Owl Creek for about 3,210 acres of land in the Lucerne Area. When finally completed and sealed, Anchor Reservoir will store 17,300 acre-feet of water to assure a supply for about 9,913 acres. In 1972, 10,921 acres were being irrigated.

b. Boysen Unit

The Boysen Dam is a flood control, power, and flow regulation dam for irrigation, municipal, and industrial uses. The Boysen Unit improves downstream late water supplies and provides supplemental water for upstream lands by exchange, but no irrigation development is included in the unit. In 1972, 50,520 acres received a supplemental water supply from Boysen Reservoir.

c. Shoshone Project

This project is based on storage and flow control by Buffalo Bill Dam. Irrigated lands in this project extend from Cody to Kane, Wyoming, and include about 92,814 acres presently irrigated by the project. Power is generated at Buffalo Bill Dam and at Heart Mountain Power Plant.

d. Hanover-Bluff

This is a pumped water supply project using Bighorn River water controlled by the Boysen Dam. There are 7,301 acres presently irrigated by this project.

e. Riverton Reclamation Project (Now a unit of the Pick-Sloan Missouri Basin Project)

Water is diverted from the Wind River near Morton to supply about 54,281 acres of irrigated land from Pilot Butte to the Boysen Reservoir. Bull Lake provides storage for this project. Power was generated at Pilot Butte Reservoir until 1973. About 56,487 irrigable acres are available for water service by the existing project.

f. Yellowtail Dam

The Bureau of Reclamation's Yellowtail Dam and Bighorn Lake and the proposed Hardin Unit irrigation project dominate the current water development scene in the Montana portion of the basin. The dam was completed in 1967 and provides storage capacities of: 259,000 acre-feet for flood control, 250,000 acre-feet for joint use flood control and conservation, 364,000 acre-feet of conservation

storage, 483,000 acre-feet of inactive storage, and 19,000 acre-feet of dead storage for a total capacity of 1,375,000 acre-feet. Historical average annual streamflow at the dam site is 2,531,000 acre-feet. The 42,600 acres of irrigation on the Hardin Unit are expected to use 131,700 acre-feet of diverted water with a net depletion of about 68,500 acre-feet with 63,200 acre-feet of return flows.

g. Huntley Irrigation Project

The Huntley Irrigation Project was started by the Bureau of Reclamation in 1905 in Yellowstone County, Montana. Water is diverted from the Yellowstone River about 15 miles east of Billings, and the project extends to Pompeys Pillar, about 36 miles east of Billings. Water for about 29,240 acres is provided by this project.

Bureau of Land Management

The Bureau of Land Management (BLM) of the Department of the Interior has the responsibility for administering the use of public domain lands and for conservation measures and land treatment on lands in the Bighorn Canyon National Recreational area. BLM administers 26 percent of the land area of the basin. They have conducted an intensive study of these lands and prepared a Land Planning and Classification Report in 1953. More recently they have applied land treatment practices toward erosion reduction and better range use. BLM is employing the multiple use concept of public lands and is developing some recreational facilities. Preservation of the fragile desert ecology will be an increasing problem as recreational use increases. Some effort is under way to identify and preserve archeological sites in the Pryor Mountain area. A study funded jointly by the Bureau of Land Management, National Park Service, and Forest Service has begun inventorying the archeological resources of the basin. Preliminary findings show that the resource is extensively distributed throughout the basin, and that there has been prolonged human habitation. Much of the resource is found in remote areas and remains in good condition. Efforts to control the use of this resource should be made to prevent destruction of this historical component of the basin.

Existing project of Corps of Engineers

The town of Greybull is protected against frequent flooding and ice jams of the Bighorn River by about 14,000 feet of levee constructed by the Corps of Engineers. The Corps also has authority to provide regulations for existing dams in the basin to prevent or reduce flood damages.

PRIVATE DEVELOPMENTS

Although federally developed and assisted irrigation projects are extremely important to the economy and social welfare of the river basin, about 60 percent of the irrigated area has been privately developed.

Individual systems on farms and ranches comprise a noteworthy part of this development. More impressive are the group enterprise developments, most of which were developed under the Carey Act, which have built reservoirs, canals, laterals, diversion dams, and control structures to provide water to many farms. These systems are constantly being improved through private initiative, often with the assistance of the programs administered through the USDA as described earlier in this chapter. New private developments are still possible and can be assisted through state programs also described earlier in this chapter.

The private development of land resources is increasing in the basin, especially in the areas of recreation and minerals. Because of the attractiveness of the area, subdivisions for year-round and part-time occupancy homes are increasing in number. The proximity of private lands to the more aesthetic recreation resources provides opportunity for development of high quality private recreational facilities at reasonable costs. These developments lessen the pressure of recreationists on public facilities. They broaden the area absorbing the recreational burden. Expanded mineral exploration is under way by the mining industry, and extraction may increase if market conditions continue to make it economically feasible. The recent interest in this area has stemmed from increased mineral prices and improved mineral retrieval technology.

Recreational and mineral developments impose related environmental and service costs on area users. If these effects are not minimized, many of the basin's desirable attributes may be jeopardized.

VII. WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

The purpose of this chapter is to describe some of the physical capability of water and related land resources to support development in the basin. These potentials are not aligned with specific projects or programs, but are identified with particular problems and needs. The reader should keep in mind that economic, legal, sociological, and political restraints and limitations are generally not considered in discussing these resource potentials. Tradeoffs are not considered, and the development of a resource for one purpose may reduce its development potential for another purpose.

AVAILABILITY OF LAND FOR POTENTIAL DEVELOPMENT

Potential for increased production on presently irrigated cropland

Much of the presently irrigated cropland is producing less than its sustained yield capacity. About 85 percent of the irrigated land in the basin could have significantly improved production through improved management, water supplies, land treatment, and water distribution systems. Irrigated land in the basin could be capable of up to 50 percent increase in total crop production.

About 37 percent or 282,000 acres of the presently irrigated cropland would have increased yield if provided a full supply of irrigation water. Most of these are haylands or pastures. If supplemental water could be supplied to these lands for second and third growth periods, they could support increased production of 50 percent or even more over present yields. With a full water supply there would be increased economic incentive for improved management, land treatment, and water distribution systems.

The use of irrigated hay and pasture lands is intimately related to the use of private and public rangelands. Improved production and management on irrigated lands should be balanced by corresponding improved treatment and management of the rangelands.

Potentially irrigable land

Data from soil surveys and reconnaissance studies of the basin indicate that large tracts of land, not presently irrigated, are suitable for irrigation. These potentially irrigable lands have suitable soils and land slopes for irrigation.

Probably the most active irrigation development at this time in the nation and in this basin is the private application of sprinkler systems both to presently irrigated and irrigable land. For example, the Wyoming Department of Economic Planning and Development has financially assisted the development of 6,600 acres of sprinkler irrigation in the basin in Wyoming since 1964.

In Wyoming nearly all of this land is presently grass or brush rangeland. A large portion of these lands are owned by the federal government, but some are state or privately owned. In Montana much of the irrigable land is presently dry cropland under private ownership.

Table VII-1 lists 1,360,750 acres of irrigable lands by general location in the basin with estimated water diversion requirements. Figure VII-1 shows specific locations. Many tracts are adjacent to presently irrigated lands. Some could be served by existing canals if additional water were provided. Other tracts could be served by extensions of existing irrigation systems. Most would require new surface or ground-water development projects to obtain water supplies.

Potential for increased production on range and dry pasture land

If all private and state range and dry pasture land were to receive improved management and treatment where needed, they could produce an estimated additional 609,800 animal unit months (a.u.m.) of roughage feed for domestic livestock and grazing wildlife. This corresponds to an increase of 0.13 a.u.m. per acre (or about a 62 percent increase) on 4,812,950 acres of this land needing improved management and treatment.

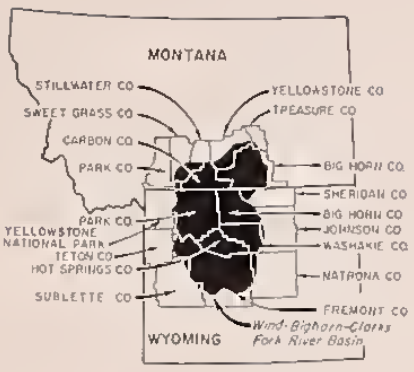
In some areas there is still potential for conversion of range to dry cropland. In Montana this amount to 1,345,000 acres. On cropable sites with adequate moisture and soils, the economic difference between returns from fallow-dryland cropping and range is heavily in favor of cropping. Most of these lands are in Big Horn and Yellowstone Counties in Montana.

Land for other uses

The availability of lands for residential, industrial, or recreational purposes may be in some competition with agriculture. The most nearly level lands with good internal drainage are most desirable for urban and industrial tract development. These same general conditions are desirable for irrigation development. Strip mining, where practical, is the most efficient way to extract coal and uranium, but this interrupts and changes existing agricultural uses.

Even though some conflicts in land use will occur, there is enough land for both agricultural and nonagricultural purposes if development is properly planned. For example, land otherwise desirable for urban purposes may be in a frequently flooded area; and agriculture, parks, and other more flood tolerant uses should be planned.

Recreational uses of land will compete with range and timber production. Recreational uses of water and water surface areas tend to compete with irrigation diversions to irrigated lands.



LOCATION MAP

LEGEND

- Potentially Irrigable Land
- Irrigated Land
- Water

FIGURE V11-1

IRRIGABLE AND IRRIGATED LAND

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

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SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

Table VII-1--Irrigable land and estimated irrigation water requirements by subbasin and state

Subbasin	Irrigable area	Water diversion requirement
	---acres---	---1,000 acre-feet---
Wind River	181,600 [1/]	696 [2/]
Bighorn River in Wyoming	642,800	2,678
Bighorn River in Montana	187,890	688
Subtotal for Bighorn River	830,690	3,366
Clarks Fork River in Wyoming	41,600	166
Clarks Fork River in Montana	56,520	211
Subtotal for Clarks Fork River	98,120	377
Little Bighorn River in Wyoming	9,600	32
Little Bighorn River in Montana	68,350	237
Subtotal for Little Bighorn	77,950	269
Stillwater River	12,830	47
Yellowstone minor drainages	159,560	609
Total Wyoming	875,600	3,572
Total Montana	485,150	1,792
Total river basin	1,360,750	5,364

1/ This estimate is based on soils and topography information and is for the entire Wind River Subbasin. The Bureau of Indian Affairs has estimated 199,000 acres of potentially irrigable land on the Wind River Indian Reservation alone.

2/ These diversion requirements are estimated for surface irrigated projects. Diversion requirements will be less per acre where sprinkler systems are installed.

POTENTIAL FOR WATER DEVELOPMENTS

Surface water

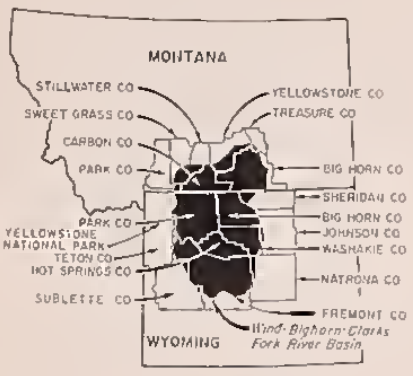
About 63 percent of the presently irrigated croplands in the basin benefit from an abundant basic water supply. Some of these lands fail to receive a full supply for their crops because of inefficiencies in transportation, management, and application of irrigation water. If project irrigation efficiencies were increased 10 percent, about 260,000 acre-feet less water could be diverted for irrigation each year, irrigated lands would be more evenly irrigated, increased production would result, and instream water quality would be enhanced. This total does not represent a net savings of water, however, since some of this water presently returns to the natural streams as surface runoff and groundwater return flow.

The potential for saving water through increased efficiencies is less in areas where the streamflow is not large enough for a full season irrigation supply. Some of the irrigated lands on the basin get less than one complete irrigation application in dry years. Increased efficiencies on these lands would result in increased production, improved water quality, and better land use. However, the main incentive to increase water use efficiency on these lands is to use the water on additional adjacent lands with the result of a net reduction of water to downstream areas.

There are about 241,600 acres of phreatophyte areas in the basin. About 80 percent of this area is natural. The remaining 20 percent is associated with agricultural irrigation development. Phreatophytes use about 600,800 acre-feet of water each year. Any reduction in consumptive use of water in phreatophyte areas should result in a net water savings of nearly the same amount. If a 25 percent reduction of phreatophytes in 20 percent of the area and a 10 percent reduction in 80 percent of the area could be achieved, about 78,000 acre-feet of water would be saved each year. This might be achieved through chemical and mechanical removal of plants, channel modification, improved agricultural water management, drainage, or other means. Any attempt at phreatophyte reduction in this basin should be carefully evaluated with regard to effects on fish and wildlife habitat and to costs of alternative ways to save water.

Additional development of water for irrigation would require new systems of diversion, pumps, canals, pipelines, and storage reservoirs. Even in the most water-short areas, there is water that could be stored during high spring flows and short summer floods. The mainstreams of the Wind River, Bighorn River, Clarks Fork River, Shoshone River, Stillwater River, and several of their major tributaries are water-abundant areas which supply most of the more than 4,000,000 acre-feet flowing from the basin annually.

A number of possible reservoir sites have been identified and are shown in figure VII-2. Additional information about these sites may be found in the Montana and Wyoming Supplements to this report. In this



LOCATION MAP

LEGEND

12● Possible Reservoir Sites

FIGURE V11-2

POSSIBLE RESERVOIR SITES

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

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ALBERS EQUAL AREA PROJECTION

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report the term "possible reservoir site" means only that a topographically favorable reservoir site exists and that some information about potential capacity or intended purpose is available. A number of these sites may be unfavorable because of poor foundations or high construction costs.

If sites could be developed to store all available storable water within water-short areas, there would still be water shortages in some areas. If this shortage is to be reduced, new water sources must be developed. One source might be transfer of surface water from the larger streams in the basin. For example, it is physically possible to build aqueducts from upper Wind River to provide supplemental irrigation water to most of the presently irrigated lands in the central portions of the Wind River and Bighorn River Subbasins. Some of the irrigable land in the basin could also be supplied this way. However, this system would be very expensive and probably not economically feasible at present. Large storage reservoirs would be needed to make the system efficient and provide late season water. Uncertainty with regard to appropriated versus reserved water rights also restrains development of transfers at this time.

There is potential for developing new pump systems to lift water from the mainstems of some of the larger rivers. For example, it is possible to pump water from the Bighorn River to supply water-short areas in the lower portions of tributary watersheds. Pumping and installation costs rapidly increase as distances, pumping pressures, and amounts of water increase. Large scale developments of this type will be limited by these factors.

Some projects for development of new lands through storage and transfer of water within the basin have been proposed by the Bureau of Reclamation. These are discussed in more detail in Chapter IX of this report. More information can be obtained from the Bureau of Reclamation.

Additional hydroelectric power can be developed in the basin. There is a power reservation site on East Rosebud Creek. There is no readily available estimate of power potential, but the estimated cost of storage is only $25 per acre-foot, and the 80 percent chance yield is about 116,000 acre-feet. Another potential site is in Clarks Fork Canyon in Wyoming. The Bureau of Reclamation has estimated that this site can develop 177,500 kilowatts. Both sites would also provide recreation and other benefits.

While there are ecological and economic arguments which favor hydrogeneration over using available resources of fossil and fission fuels, the potential for hydropower falls far short of the power needs of the nation and the region. Most of the electric power generation in the near future in this region will probably come from coal-fired, steam-powered generating plants. These plants generally use about 15,000 acre-feet of water per year per 1000 megawatt plant. Most of them will be located outside this river basin but may transport water from this basin.

There is potential for transfer of water from this basin for coal and power development outside the basin in eastern Wyoming and Montana.

Water stored in Clarks Fork Canyon could also be used by thermoelectric generating plants on the Yellowstone River. The cost of development and the value of water for other uses would seem to be ultimate determining factors in the case of local versus distant use.

Ground water

Ground water in amounts up to 450 gallons per minute (g.p.m.) from depths of less than 100 feet can be developed in valley alluvium along major drainages in the basin. The potential for large scale water development from valley alluvium is limited because of thin aquifers and the possibility of depleting surface flows in associated streams.

Up to 25 g.p.m. may usually be obtained within depths less than 600 feet on the basin floor in bedrock formations of the Tertiary Age. Steeply inclined older formations outcrop around the margin of the basin floor. Aquifers in these formations may yield sufficient water with artesian pressure for irrigation use. Depths to these aquifers vary widely as does the quantity and quality of water obtained from them. The potential for large producing wells of this type is restricted to a narrow band along the margin of the basin floor, and careful site selection is required.

The potential for artificial recharge of aquifers is very limited in the basin. If new lands are developed on the benches in the midwestern portion of the Bighorn River Subbasin, a shallow body of ground water will probably form in gravel deposits which might provide potential for new wells.

Potential for municipal and industrial water supply

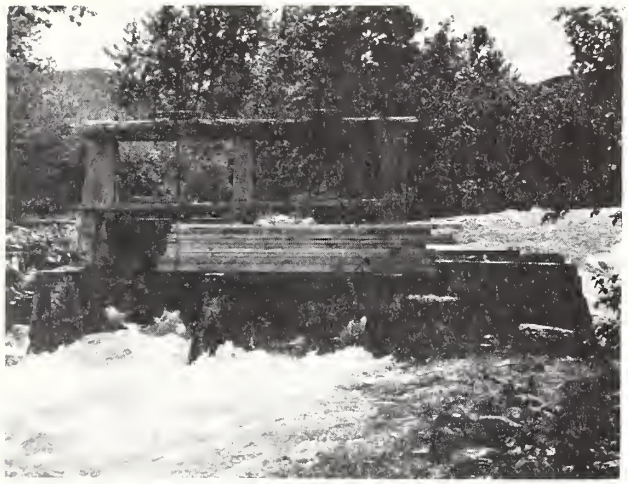
There is high quality surface water available for municipal and industrial development along the larger streams of the basin. Ground water may also be developed. However, ground water in some parts of the basin is highly mineralized and should not be used for human consumption.

POTENTIAL FOR CHANNEL IMPROVEMENTS AND LEVEES

There is potential for channel improvement, streambank protection, and levee construction to reduce erosion and flood damages along many of the streams and rivers in the basin. However, in practice, the installation of these measures is not generally economically justified except for short reaches to protect roads, railroads, towns, bridges, irrigation diversion structures, and high valued irrigated cropland. In some locations it may be better to relocate buildings out of the flood plain than to build levees to protect them. Some of the above practices may be installed for environmental reasons.

POTENTIAL FOR WATER TABLE CONTROL

The most suitable method to obtain water table control is to combine



Irrigation diversion on Rock Creek above Red Lodge needs to be replaced.

Golden Ditch diversion out of Clarks Fork River before reconstruction, 1959.







Golden Ditch diversion after reconstruction, 1961, eliminating annual diking and pollution of the river.

improved irrigation water management and irrigation systems with improved drainage systems. On about 85 percent of the 145,900 acres of wet and saline soils in the basin, water table control can be improved through better irrigation water management systems. Nearly all of this same area would also benefit from improved drainage systems. About 30 percent of the area must have improved drainage systems to achieve effective water table control. Some of this area has been irrigated in the past, is not irrigated now, and will require some irrigation for full production after drainage is installed.

About 15 percent of the wet and saline soils of the basin cannot be effectively drained or improved for agriculture. Some of these areas can be managed as salt and water tolerant pastures or as wildlife pastures and recreational areas. It should be noted that marshlands, which are so vital to waterfowl and other species, are not included in the estimate of drainable lands. There is very little marshland in the basin, and no accurate estimate of its area is available.

POTENTIAL FOR IRRIGATION SYSTEM IMPROVEMENT

The physical potential exists to improve nearly all irrigation systems in the basin. This can often be accomplished best by a total system approach on a group project basis. Delivery systems can be upgraded by the installation of more efficent flood resistant diversion structures; division, control, and metering structures; and through canal consolidation, relocation, rehabilitation, and lining.

When properly designed and operated, ditch lining and land leveling can increase on-farm irrigation efficiency as much as 30 percent. Properly managed and constructed furrows and corrugations can increase field application efficiencies to 70 percent. Level and graded borders and sprinklers can increase field efficiency to 80 percent with good management. Conversion to sprinkler systems has the greatest economic potential where soils and climate will accommodate high value crop production. Where surface irrigation methods persist, there is potential for recycling tailwater. Most tailwater is of adequate quality for reuse as irrigation and livestock water. Land smoothing and leveling allow doubling of field irrigation efficiencies in some irrigated areas.

POTENTIAL FOR RECREATION DEVELOPMENT

Development potentials in recreation can be broken into two general categories. The first would consist of improving the use of existing opportunities and resources. A second consists of providing new opportunities and developments. Recreation use occurs on public as well as private lands in this basin, and both have a potential for expanding recreation opportunities.

Some of the public land areas have developed recreation facilities. Generally, these areas are accessible through some type of road or trail

system. However, recreation use is almost nil on a large part of the public land because of the lack of passageways or because these areas are "land-locked" behind a buffer zone of private land. Improved accessibility to public land is needed and can be accomplished by acquiring access across private land. Large blocks of public domain, national forests, and state-owned land are used on an annual basis by livestock producers. Grazing rights often have been and continue to be interpreted by the holder as rights to exclude all other users from multiple use of federal and state lands. Where the only practical entry to public land is across private holdings and if the multiple use concept is to be realized thereon, then access needs to be acquired through either negotiation or court action. This is one potential for providing much additional recreation opportunity at a relatively small annual cost.

Private lands near public lands may be the best opportunity to provide additional developed recreation facilities. This is the most likely way in which some types of recreation facilities can be provided when public construction funds for this purpose are limited. Public monies could then be used for purposes that supplement investments made in the private sector. There are good potential sites for either public or private campground development on or near public lands. If developed facilities can be provided by the private sector, public funds could be used for access roads, etc. Thus, recreationists will pay the relatively high costs of providing the facilities they desire while maximizing recreation opportunities for all persons through the public fund expenditure on access. It is possible that if recreation resource users have to pay the full cost of using this resource, their recreation preferences may change.

There may be a potential for developing small, lowland lakes that are close to towns and roads for use in water-skiing. Existing large bodies of water provide only limited use for water-skiers because the water is too cold much of the year. Also, the large surface area of the water can be adversely affected by winds and result in high wave action.

Sightseeing and pleasure driving are a part of the total recreation experience for most vacationers. Providing additional scenic areas should be considered, particularly when these areas purvey a varied view. About 400 square miles of mostly public land located east of Meeteetse, Wyoming, has considerable potential as a scenic area. It is an area of low rainfall, sparse vegetation, and a panorama of colored bluffs, hills, mesas, and plains. It is close to two major access routes between Yellowstone Park and the Bighorn Mountains. This area is at a relatively low elevation and could accommodate campers for longer periods than at a higher elevation. Also, this area could be used as a staging area campground for visitors headed toward national parks.

There is good potential for developing hunting and fishing access areas along streambanks and lakeshores. Such accesses can be purchased, governed, and managed by the states. Costs for land rights and providing facilities might be shared between federal and state funds.

POTENTIAL FOR FISH AND WILDLIFE HABITAT IMPROVEMENT

Fishery

Low streamflows in late summer, reservoir drawdown during spawning season, sedimentation, winter kill, undesirable fish populations, livestock disturbance of channels, infertile water, and oil field wastes are factors which prevent maximum desirable fish production in the basin. Control of these and other factors in the basin would improve fish and wildlife habitat. A table in each of the State Supplement Reports provides more detailed information about how this potential can be developed.

Big game

Big game herds could be increased if additional winter grazing were provided. This could be done through range restoration, selected forest thinning, erosion control, reduction of livestock grazing, plantings, construction of watering facilities, fertilization of winter ranges, and other practices.

Waterfowl

Waterfowl habitat is quite limited in the basin. Reservoirs and lakes are important habitat; but small ponds, reservoirs, and marshlands are extremely important to waterfowl, and these are quite limited in the basin. There is a potential to increase these small water areas. Waterfowl habitat can be further improved by providing more protected food, cover, and nesting sites near these small water areas.

Upland game and other wildlife

Habitat for upland game and other wildlife can be improved. Food, undisturbed cover areas, and watering facilities can be provided on private and nonprivate land.

POTENTIAL FOR WATER QUALITY IMPROVEMENT

Agriculture

Irrigation return flows contain dissolved minerals, sediments, and sometimes chemicals. The amount of these pollutants depends on soils, geology, type of irrigation, degree of water control, use of chemicals, and other farming practices. The latter four factors can be controlled. Sprinkler irrigation can be managed for zero surface runoff of irrigation water. Agricultural chemicals can be applied in a way to minimize downstream pollution. Tillage can be done to minimize soil loss. Grazing can be managed so a good ground cover is maintained and feedlot wastes can be controlled and treated. The control of feedlot wastes will become more important as cattle feeding expands in the basin. There is potential to increase these and other means of improving water quality through education and assistance in applying improved land and water management practices.

Municipal, industrial, and other urban uses

Federal and state laws require permits for waste discharge from towns, cities, industries, and others. Permits are issued in accordance with a program designed to eliminate pollution. There is potential to improve water quality by providing new or improved waste treatment facilities for several communities and local industries.

Recreation

Outdoor recreation is an important factor in the development of the basin. Wastes associated with recreation activities are costly to control because of their dispersion. One way to reduce this problem is to provide sanitary and waste collection facilities at intensive use areas.

ASSOCIATED LAND TREATMENT AND ADJUSTMENTS

There is some potential for land use conversion. The potential for conversion of rangeland to irrigated cropland was discussed earlier in this chapter. Changing some marginal cropland to wildlife habitat and recreation land could bring environmental, economic, and quality of life benefits.

FOREST LAND DEVELOPMENT POTENTIAL

Potential for outdoor recreation

The major forest landowners and management agencies have accurate and recent estimates of the potential for recreation development. The Bureau of Land Management and the Forest Service together are responsible for administering more than half of the land in the basin, including sites with a current capacity of about 1,660,000 visitor days per year. Another 998,000 visitor days of annual use can be satisfied on potential development sites inventoried.

There is additional potential for recreation site development on private forest land on the Wind River Indian Reservation, in state parks and other lands, and in Yellowstone National Park. With the additional undeveloped capacity of wilderness areas, Yellowstone Park, national forests, badlands, and other wild land in the public domain, it appears that the projected demand can be satisfied; and there would still be potential for additional recreation activities in the basin. One factor that could limit the realization of the full potential is lack of permanent public access to national forest land through Indian reservations and private land. These management and utilization potentials are also affected by significant changes in management objectives. The national forest lands, which were managed primarily for timber production in the past, are now managed to emphasize aesthetic, wildlife, and recreation values as well. The forest lands of the Wind River Indian Reservation are expected to be managed with a near total exclusion of timber management activities. These management policies will have both positive and negative effects on the potential uses

of reservation forest lands. The Forest Service is starting to emphasize recreation development at destination sites while de-emphasizing the roadside campgrounds that serve as little more than bedrooms for passing tourists. The development of roadside campgrounds is felt to be more appropriate for private investment, and they are beginning to emerge as the market expands. The Forest Service may provide assistance to private developments.

Potential for forest land grazing

No specific need or unfulfilled demand for grazing has been identified. However, there is a trend toward expanded livestock production. In the future there may be increased pressure on forest range. Before an increase in grazing is allowed, the alternatives should be carefully evaluated. Intensive management and installation of fencing, water facilities, and range revegetation could increase the grazing potential. Some changes in management philosophy could affect the distribution of use but not the capacity.

Potential development for timber

Although the theoretical potential for meeting the 2020 demand for timber exists, it is unlikely that the potential will ever be realized. The supply of timber could be increased by approximately 50 percent by decreasing current losses due to diseases and insects. Timber from land clearing, thinning, and other operations could be utilized more efficiently, and wood processors could improve utilization in their operations. This could provide about a 70 percent increase in usable wood. Finally, intensified forest management, reforestation and regeneration, and new methods of harvesting on stands not presently harvestable could provide a 50 percent increase in the wood supply.

Potential development for forest wildlife and fisheries

Most of the forest land is classed as summer range. This habitat can be manipulated and intensively developed to support more wildlife. The treatment would have little effect on wildlife populations, however, since the lower elevation winter range is more critical. There is potential to manage the winter range to support more wildlife. Much of the winter range is privately owned.

Stream fisheries can be improved, restored, or enhanced, and additional reservoirs can be developed to provide variety. The physical potential for fisheries development appears sufficent to satisfy projected demands.

Potential forest land development for water management and water quality

The needs for water management will be provided mainly through structural development and other project means. However, there may be potential for increasing water yield and prolonging water release through vegetative management in forest areas. Research is currently under way,

and early results are promising. However, there has not been enough application to justify extension of research findings from experimental areas to general forest areas. In addition, this basin has constraints on this type of work since most of the high elevation forests are classified as wilderness or primitive areas; and vegetative manipulation is prohibited by congressional statute. The primary water pollutant from forest land is sediment. There is potential for land treatment and regulation to reduce the causes of sediment production on lands not in primitive and wilderness areas.

ENHANCEMENT OF NATURAL BEAUTY

It is no longer practical to plan for development without considering visual effects. If the development is to harvest timber or to strip mine for coal, the public demands that trash be cleaned up, scars be healed, and the area be revegetated. Water storage and control structures and recreation facilities should be designed to fit the landscape of which they become a part.

Another way to enhance natural beauty is to complete the land treatment needed in the basin. This will heal erosion scars, improve vegetation, and reduce sediment pollution of water.

VIII. OPPORTUNITIES FOR DEVELOPMENT AND IMPACTS OF USDA PROGRAMS

This chapter describes identified opportunities for project development through USDA programs. Physical and economic impacts of these projects are discussed. Through the identification of these projects and their impacts, it is hoped that a coordinated, priority-oriented development can be accomplished. This report is a summary for the entire basin. More detailed information can be found in each of the state supplements, watershed investigation reports, and information in the files of the federal agencies involved in the study. The general provisions of USDA programs were discussed in chapter VI.

OPPORTUNITIES FOR WATERSHED PROTECTION AND FLOOD PREVENTION

Study procedures

There are 127 defined watersheds in the Wind-Bighorn-Clarks Fork River Basin. There are 83 entirely in Wyoming, 30 entirely in Montana, and 14 that have a part in each state. All were investigated, to some degree, to determine whether watershed projects would solve watershed problems or enhance resource development. Figure VIII-1 is a map showing the degree of investigation of the watersheds. Those watersheds shown on the map as having "cursory investigation only" were so limited in physical potential for project development that there was no detailed investigation. For the watersheds that appeared to have physical potential for project action, a detailed field investigation was conducted. If the detailed investigation showed that costs would exceed the benefits, no formal report was made. Where the potential for an economically feasible project was found, a watershed investigation report was written.

All of these proposed projects could be considered as having a high priority. However, a number of criteria, such as critical resource needs, economic return, and number of beneficiaries, were used to determine the watersheds with the highest priority. Three proposed projects in Wyoming and five in Montana have been selected as high priority watersheds.

An additional factor that needs to be considered in determining the priority of any project involving the storage of water for agriculture is that they should be developed as soon as possible so as to establish the rights for this use. After agriculture water rights are established, industry and other water users can generally afford to develop the remaining water supply whatever the cost. On the other hand, water storage for agriculture will probably not be economically possible if other interests obtain water rights first.

Summary of physical and biological effects of proposed watershed projects

Watershed investigation reports have been written and distributed for 21 potential small watershed projects in the basin. The impacts and land use changes for each of these proposed developments are listed in table VIII-1. A more detailed explanation of each project is contained in the state supplement reports.

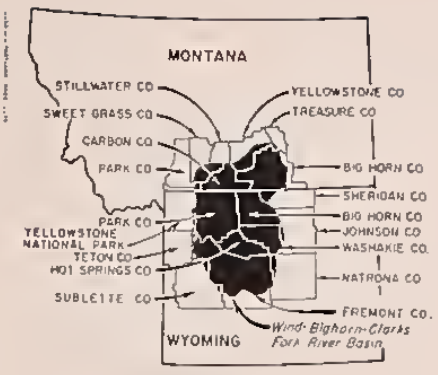
Development of the 21 small watershed projects will provide about 86,400 acre-feet of water available for improving late season irrigation water supplies each year. This same development would reduce annual streamflow from the basin by about 72,500 acre-feet. In-stream sediment would be reduced about 140 acre-feet per year by 14 reservoirs. Most of the proposed projects could provide improved waterfowl habitat. Some could improve fish, antelope, and upland game habitat. A few, notably Crow Creek near Tiperary and Upper Beaver Creek in Wyoming, would have some adverse effect on deer, elk, or moose habitat. This adverse effect could be mitigated through habitat improvement measures in these projects.

The completion of these projects would require some land use changes. About 27,000 acres of rangeland would be converted to irrigated cropland. About 31,000 acres of cropland with poorly drained and saline soils would be improved. Nearly 3,300 acres of land would be converted to water surface, and about 1,600 acres near these new bodies of water would be converted to recreational use. The combined capacity for recreation in the basin could be increased as much as 200,000 visitor-days each year.

Economic impacts of proposed watershed projects

Installation of watershed projects proposed in this study can provide a stimulus toward economic growth and development. The complexity of relationships that exist between various sectors of the local economy and how they relate to the region and the nation make it an intricate, if not impossible, task to quantify all effects likely to occur. The basin's economy is made up of the aggregate economic activity of all its people. An initial change in one of its basic sectors will signal adjustments to take place in other sectors which will induce further changes, and so on. The result of these changes can be quantified in terms of employment and income.

Employment will be generated as the works of improvement become operative. An employment multiplier can be used to estimate this impact. This approach involves a breakdown of total employment into two major occupational groups: (1) The basic group which includes agriculture, forestry, manufacturing, and mining produces goods and services for consumption mainly outside the basin; and (2) the derivative or service-oriented group which includes those industries whose goods and services are mainly consumed locally. Some services would be considered basic in that service sold to tourists brings new money into the basin. Tourist service activity has not been measured in this study. Total employment and incomes rise and fall with the basic group. A change in the basic activities sets a chain reaction in motion that is reflected through all sectors of the economy.



LOCATION MAP

WATERSHEDS INVESTIGATED
FOR SMALL PROJECT ACTION

- Watershed investigation report completed
- Detailed field investigation but no report published
- Cursory investigation only

FIGURE VIII-1

WATERSHEDS

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

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LAMBERT EQUAL AREA PROJECTION

Table VIII-1--Summary of potential small watershed projects and their impacts, Wind-Bighorn-Clarks Fork River Basin

Watershed number and name	ECONOMIC IMPACTS				PHYSICAL AND BIOLOGICAL IMPACTS								
	BENEFITS	COSTS		Benefit to cost ratio (annual)	Average annual surface water quantity change	Water supply timing improvement	Sediment load reduction	Vegetation improvement	Erosion reduction	Fish and wildlife		Increased recreational use	People served with new community water supply
	Annual Benefits 1/	Total installation cost	Annual cost 2/							Location with improved habitat	Location with reduced habitat		
	$/yr	$	$/yr	ratio	AF/yr	AF/yr	AF/yr	acres	acres	acres of land or water or miles of stream		visitor days/yr	number
PRIORITY WATERSHEDS													
WYOMING													
14e5-4 Lower Greybull	821,000	3,900,000	264,580	3.1:1.0	+3,000	0	0	31,600	31,600	10,400 ac.	0 ac.	37,000	0
14e4-1-7 Nowood River Watersheds	200,370	1,627,500	111,220	1.8:1.0	-3,500	13,000	55	3,000	3,000	3,550 ac.	3,560 ac.	-	0
14c-15 Cooseberry Creek	71,000	832,000	51,400	1.4:1.0	-1,400	3,665	0.25	0	0	175 ac.	175 ac.	-	0
MONTANA													
14-27 Blue Creek	252.870	3,183,810	206,590	1.22:1.0	-420	2,460	9.5	-	-	5 mi.	0	17,610	400
14d-1&2 Pryor Creek	365,450	2,797,300	188,980	1.93:1.0	-6,265	9,902	28.0	4,207	-	0	2 mi.	57,275	-
14e-37g Two Leggins Irrg. Unit	648,790	5,147,370	342,100	1.90:1.0	-	-	-	8,900	-	nil	nil	-	-
14e7-1 Upper Little Bighorn River	100,700	436,520	26,850	3.75:1.0	-5,800	-	-	2,900	-	0	0	-	-
14e7-3 Lodge Grass Creek	41,000	580,630	34,900	1.17:1.0	-	-	5.4	-	-	0	6 ac.	3,375	-
Subtotal	2,501,180	18,505,130	1,226,620	2.04:1.0	-14,385	29,027	88.15	50,607	-	-	-	-	-
OTHER WATERSHEDS 3/													
WYOMING													
14e6-8 Sage Creek-Pryor Mountain	122,180	1,063,770	65,580	1.9:1.0	-600	1,480	1	0	0	170 ac.	170 ac.	-	0
14e-23 Lower Shell Creek	51,500	546,900	34,120	1.5:1.0	-1,300	3,370	1	0	0	203 ac.	213 ac.	-	0
14e1-5 Crow Creek near Tiperary	118,230	854,000	52,210	2.3:1.0	-1,600	9,900	1	2,600	2,600	2,845 ac.	2,845 ac.	-	0
14c-5 Cyclone Bar	134,240	840,000	58,030	2.3:1.0	-1,700	4,950	3	0	0	400 ac.	400 ac.	-	0
14e1a-5 Upper Beaver Creek	109,735	968,800	60,400	1.8:1.0	-1,400	12,900	16	766	766	1,196 ac.	1,196 ac.	-	0
14e-27 Crooked Creek	36,900	234,500	17,850	2.1:1.0	-3,100	7,000	0	0	0	0	0	-	0
14e3-2 Upper Badwater Creek	39,120	546,000	33,340	1.2:1.0	-400	1,620	1.5	0	0	70 ac.	70 ac.	-	0
14e1-9 Midvale	580,550	2,490,730	237,250	2.4:1.0	-35,000	0	0	16,830	16,830	16,830 ac.	16,830 ac.	-	0
14e1-9 Hidden Valley	57,400	253,500	15,970	3.6:1.0	-300	-	0.6	0	0	28 ac.	28 ac.	-	0
MONTANA													
14e7-5 Little Bighorn East Side	93,860	355,730	27,520	3.41:1.0	-4,540	-	0.0	2,270	-	-	-		
14-31, 32, & 36 Huntley Irrigation Project	383,000	1,952,600	125,320	3.06:1.0	-	-	-	11,700	-	nil	nil	-	-
14c-10 Elbow Creek	209,665	1,790,600	117,510	1.78:1.0	-5,550	10,450	7.0	1,400	40	0	35 ac.	41,135	-
14c-11 Bluewater Creek	230,650	1,900,280	127,050	1.82:1.0	-2,600	5,698	11.0	5,334	-	5 mi.	0	46,220	-
Subtotal	2,167,030	13,797,410	972,150	2.23:1.0	-58,090	57,368	42.1	40,907	-	-	-	-	-
TOTAL	4,668,210	32,302,540	2,198,770	2.12:1.0	-72,475	86,395	140.25	91,507	-	-	-	-	-

1/ Additional information may be found in State Supplements and Watershed Investigation Reports.

2/ Installation cost amortized at 5 5/8 percentage rate plus annual operation and maintenance costs.

3/ Some of these watersheds may become priority watersheds.

Table VIII-1--Summary of potential small watershed projects and their impacts
Wind-Bighorn-Clarks Fork River Basin
(Continued)

Watershed number and name		LAND USE AND AVAILABILITY CHANGES							Potential for state agency involvement
		Rangeland to cropland	Wetland to improved cropland	Cropland to wildlife and recreation land	Rangeland to recreation land	Land to water surface	Cropland with improved production	Rangeland with improved production	
		acres							
	PRIORITY WATERSHEDS								
	WYOMING								
4e5-4	Lower Greybull	0	10,400	0	0	N/A	31,600	-	Development of Badlands Scenic Area
4e4-1-7	Nowood River Watersheds	3,000	0	0	10	550	0	-	Irrigation and recreation cosponsor
4e-15	Gooseberry Creek	0	0	0	0	175	2,110	-	Transwatershed water development
	MONTANA								
4-27	Blue Creek	0	0	0	320	168	0	-	Recreation cosponsor
4e-162	Pryor Creek	2,285	0	200	800	335	1,922	2,285	Irrigation and recreation cosponsor
4e-37g	Two Leggins Irrigation Unit	0	8,900	0	0	0	8,900	-	
4e7-1	Upper Little Bighorn River	0	0	0	0	0	2,900	-	Irrigation cosponsor
4e7-3	Lodge Grass Creek	0	0	0	27	27	0	-	
	Subtotal	5,285	19,300	200	1,157	1,255	47,432	2,285	
	OTHER WATERSHEDS								
	WYOMING								
4e3-8	Sage Creek-Pryor Mountain	0	850	0	0	170	4,850	-	Recreation cosponsor
4e-23	Lower Shell Creek	0	0	0	10	203	1,940	-	Recreation cosponsor
4e1-5	Crow Creek near Tiperary	2,600	0	0	0	245	1,200	-	Irrigation and recreation cosponsor
4c-5	Cyclone Bar	0	0	0	0	400	5,060	-	
4e1a-5	Upper Beaver Creek	766	0	0	0	430	2,034	-	Recreation and wildlife cosponsor
4e-27	Crooked Creek	0	0	0	0	0	1,400	-	
4e3-2	Upper Badwater Creek	0	0	0	0	70	1,700	-	Recreation cosponsor
4e1-9	Midvale	15,580	0	0	0	0	0	-	Irrigation cosponsor
4e1-9	Hidden Valley	0	0	0	0	28	2,362	-	
	MONTANA								
4e7-5	Little Bighorn East Side	1,135	0	0	0	0	1,135	1,135	
4-31,32, & 36	Huntley Irrigation Project	0	11,700	0	0	0	11,700	-	Drainage cosponsor
4c-10	Elbow Creek	500	0	0	400	235	6,182	500	Irrigation and recreation cosponsor
4c-11	Bluewater Creek	0	0	0	0	235	5,354	-	Irrigation and recreation cosponsor
	Subtotal	20,581	12,550	0	410	2,016	44,917	1,635	
	TOTAL	25,866	31,850	200	1,567	3,271	92,349	3,920	

A ratio of basic employment to derivative employment was computed from U. S. Census of Population reports for each subbasin. This ratio is not static. The number of employees in the derivative group is becoming larger relative to the basic group over long periods of time. This trend is expected to continue. A basic-derivative ratio applicable to the entire basin for year 2000 is estimated at 1:3.25, derived from the following table:

Year	Part of basin	Total	Basic employment	Derivative employment	Basic-derivative ratio
1940	Wyoming	15,953	8,765	7,188	1:0.82
	Montana	8,512	5,476	3,036	1:0.55
1950	Wyoming	22,001	9,167	12,834	1:1.40
	Montana	8,610	4,798	3,812	1:0.79
1960	Wyoming	24,790	9,111	15,679	1:1.72
	Montana	7,847	3,465	4,382	1:1.26
1970	Wyoming	25,289	8,416	16,873	1:2.00
	Montana	7,085	2,572	4,513	1:1.75

Basic-derivative ratios for the state portions were weighted by agricultural employment to arrive at the estimate for the basin.

The combined effects of changes in land use and crop yields on the benefited acres are major determinants used in evaluating the economic impact. About 122,000 acres in the investigated watersheds will be affected. Changes in land use are expected on only part of the total; however, nearly all of the benefited area will be used more intensively and efficiently. Hay, silage, and feed grain production will be increased while pasture and range production will decline because of fewer acres.

By 2000, with the resource developments in place and operative, the annual gross value of agricultural production will be increased $7,404,000. Approximately 54 percent of the increase ($4,004,000) will come from lands that are irrigated at the present time but need either additional water or the removal of excess water. Supplemental irrigation water will be provided by the projects. The remaining 46 percent ($3,400,000) will come from land that is currently used for grazing and dryland crops but will be developed for irrigation as a part of the project.

Projected economic benefits will be realized across the basin and will contribute to economic development objectives. To the extent that additional agricultural production and associated economic activity merely displaces production and activity in other areas or affects market prices, the benefits may not truly be national gains. Agricultural products of this basin are not of the type heavily influenced by international exports. Therefore,

this study assumed that output increasing effects of the proposed developments are so small on an interregional basis, that any displacement or price effects would be insignificant.

The value of production per agricultural employee in the year 2000 is estimated at $34,230. [1/] If it is assumed that agricultural labor resources will be fully employed in 2000 without the plan, the additional agricultural output will provide for 214 additional basic employees. By applying the employment multiplier, it can be shown that derivative employment can increase by 696. The total impact on employment resulting from the increased agricultural production associated with the programs is estimated to be as much as 910 employees. This is comparable to providing for all males between the ages of 30 to 49 in the study area that were reported as nonworkers in 1970. Conversely, if it is assumed that labor resources are underemployed to the extent that the increased production can come about without affecting employment, the basin-wide effect amounts to an average of an additional $380 of net farm income per farm worker.

After deducting the nonfederal share of annual project costs from primary benefits, the remainder (approximately $2.9 million) can be considered as income to the basin. This increase in income is available for consumption spending. A portion of this increase will be spent in the basin, and in turn, respent within the area until its marginal effect becomes zero. A summation of these successive rounds of spending is commonly called the income multiplier. This indicator measures the total change in a particular sector. Recent studies in areas similar to the basin estimate the income multiplier to be about 2.0. If the entire $2.9 million were dispersed in the basin, the total income effect would be at least $5.8 million annually, which is an average of $50 per resident. No attempt was made to project the income multiplier for 2000. However, as the basic-derivative employment ratio changes, the income multiplier will react in a somewhat similar fashion.

Local benefits can also accrue through the investment of nonlocal funds for resource developments. The federal share of the costs for watersheds investigated in this study is estimated to be $16,216,000. If a 15-year period is required for project installation and federal funds are provided in equal increments over the period, this is equivalent to $1,081,000 annually. All of this investment can represent new income to the study area provided that a local contractor is employed and he purchases capital, labor, supplies, and machinery within the study area. The local area could be enriched as much as $2,162,200 annually because the added increment of new investment income during the construction period is affected by the income multiplier.

RESOURCE CONSERVATION AND DEVELOPMENT PROJECT OPPORTUNITIES

Project measure proposals in the Beartooth RC&D area and Bighorn Basin RC&D area of the basin deal with water, land, and other natural resource

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1/ Gross value of agricultural production from table III-12 ($123,238,000) divided by the number of agricultural employees from table III-8 (3,600).

development, as well as for cultural development. Several proposals have been made for ditch consolidation and irrigation system rehabilitation and reorganization. A number of measures propose the irrigation of new land. A few propose flood control or drainage. Others involve fire protection, recreation developments, municipal water, fish and wildlife habitat improvement, predator control, improved forest practices, new or improved roads, hiking and riding trails, a grass and legume seed cleaning and processing center, sewer systems, airport expansion, and solid waste disposal systems. A number of cultural developments are also proposed. Many of the proposals can be developed as small group projects. A few would qualify as features of small watershed projects. Some will require federal assistance from agencies not in the U S. Department of Agriculture.

DEVELOPMENT OF A LAND TREATMENT PROGRAM

The concern for the proper use and management of land and related vegetative and water resources has been a primary reason for the existence of U.S. Department of Agriculture agencies since they were first created. The widespread practices of contour stripcropping, farm lot windbreaks, land terracing, gully plugs, selective forest cutting, and other such practices indicate a remarkable success in advancing the cause of proper land use in America. Nevertheless, much remains to be done before every acre of land is used according to its capabilities and treated according to its needs. Some of the practical opportunities for this basin are described in this section.

Land treatment for nonfederal lands

Proper and improved land treatment on nonfederal land is the basic concern of the Soil Conservation Service of the U.S. Department of Agriculture. Proper land treatment is the basic element of small watershed projects. Needed land treatment measures, regardless of land ownership, must be part of a watershed work plan. Acceleration of technical and financial assistance in developing land treatment measures can be provided to approved watershed project areas. Critical areas must be treated as a condition for federal assistance.

The conservation operations program of the SCS is an ongoing program to provide technical assistance and advice in soil and water conservation to landowners. Local conservation districts determine priorities for local programs. There is an opportunity to accelerate the application of land treatment practices through this program, also.

The Bighorn Basin Resource Conservation and Development Project (RC&D) in Wyoming and the Beartooth RC&D Project in Montana are both approved for operations. RC&D funds will make possible accelerated technical services for soil surveys, conservation planning, and financial assistance within approved specific project measure areas.

About 36 percent (3,309,340 acres) of the 9,176,220 acres of nonfederal lands in the basin are adequately treated. With a continuation of the existing rate of ongoing application, about 50 percent of the state and private land will be adequately treated by the year 2000. It will require a total of about $56,948,000 in installation costs to achieve this degree of land treatment. The improvement in land treatment will produce an increase of about 481,440 equivalent AUM's per year.

If the rate of application is accelerated to almost double the existing rate, about 67 percent of the state and private land can be adequately treated by the year 2000. A total of about $101,400,000 would be required to achieve this goal with the total increase in production estimated to be about 880,270 equivalent AUM's per year.

Table VIII-2 presents a more detailed analysis of the economic effects of either continuing the existing rate of land treatment application or the proposed accelerated program. An evaluation of this table shows that the major portion of the annual forage equivalent increase is a result of land treatment measures which are installed on irrigated cropland. This production increase has been estimated to be over two AUM's per acre. In addition to the production effects, these measures will improve irrigation efficiencies, control erosion, improve water quality, and reduce operation and maintenance costs.

The best rate of return for land treatment investment will be on rangeland with the average annual forage increase in yield estimated to be from 0.26 to 0.38 AUM's per acre.

National forest development and management opportunities and impacts

Development

The discussion of forest land development potential in chapter VII indicates that there is ample opportunity for accelerated development on National Forest land. The implicit assumptions underlying the identification of potentials and of problems and needs are that the region will continue to supply forest related goods and services at a rate equal to that of the immediate past. Because the timber industry has been responsive to the market, this is roughly analogous to the National Economic Development Objective described in the Water Resources Council Principles and Standards.

The opportunities for development to help meet projections of demand for timber, recreation at developed sites, forage, and fish and wildlife are shown in table VIII-3. Early action is an opportunity on the five potential small watersheds which include National Forest lands. Forest Service development can be accelerated in conjunction with PL 566 projects on these areas if sufficient additional funds such as Water Resource Development and Related Activity Program (WRDRA) money is provided. National forest development programs and projects could be accelerated to include almost all the remaining opportunity. Additional funds and manpower would be essential to convert these opportunities to reality.

Table VIII-2--Economic effects of land treatment alternatives on state and private land

Land Use and Treatment Practice	Area Needing Land Treatment	Projected Existing Programs: Applied by year 2000	Projected Existing Programs: Installed cost	Projected Existing Programs: Annual forage Equiv. Incr. 1/	Proposed Accelerated Programs: Applied by year 2000	Proposed Accelerated Programs: Installed cost	Proposed Accelerated Programs: Annual forage Equiv. Incr. 1/
	---acres---	---acres---	---dollars---	---AUMs---	---acres---	---dollars---	---AUMs---
Irrigated Cropland							
Irrigation and/or drainage systems	399,420	90,110		279,900	155,830		484,100
Cultural management measures	77,763	26,440		6,600	43,720		10,900
Water management measures	174,554	43,780		76,600	64,380		112,700
Subtotal	651,737	160,330	49,100,000	363,100	263,930	83,600,000	607,700
Nonirrigated Cropland							
Cultural or management measures	209,017	34,500	1,458,000	750	69,710	2,945,000	1,580
Range and Dry Pasture							
Planned grazing systems	3,794,638	836,820		83,650	1,963,540		196,400
Brush and weed control	973,405	137,360		23,410	321,020		53,720
Reseeding	29,933	7,840		3,970	19,580		9,840
Range renovation	14,975	890		450	1,890		900
Subtotal	4,812,951	982,910	4,000,000	111,480	2,306,030	9,725,000	260,860
Forested Land							
Forage improvement	194,340	68,840		6,910	114,990		11,530
Reduction of grazing	46,940	9,050		- 800	16,090		- 1,400
Subtotal	241,280	77,890	490,000	6,110	131,080	805,000	10,130
Other Lands							
Vegetative and structural measures	41,148	11,920	1,900,000	NA	26,870	4,325,000	NA
TOTAL	5,956,133	1,267,550	56,948,000	481,440	2,797,620	101,400,000	880,270

Price base 1974 costs. NA = Not Applicable.

1/ All crop and forage production converted to AUMs of forage equivalents (i.e. 450# corn or 900# hay = 1 AUM.)

Table VIII-3--Comparison of land treatment and structural measures planned and opportunities for an accelerated development alternative, Bighorn and Shoshone National Forests, Wyoming, and Custer and Gallatin National Forests, Montana, 1970

Project Item	Unit	Estimate Unit Cost	Currently Planned	Development Alternative Opportunities	
				Potential PL-566 action	Other long range action
		---dollars---			
Range revegetation & plant control	acres	10-20	14,600	2,200	19,800
Range distribution trails	miles	200-600	160	3	127
Range fences	miles	2000-2500	388	30	277
Forest planting or seeding	acres	220	5,780	100	900
Forest Management:					
Insect control	acres	25-250	700	500	4,300
Disease control	acres	5-70	0	3,400	30,600
Release, harvest, thinning, weeding	acres	30-70	23,100	6,400	17,600
Fishing stream improvement	miles	200-2000	40	40	780
Fishing lake improvement	acres	3000-10,000	200	360	4,190
Waterfowl habitat management	acres	400-600	0	5	20
Fence key wildlife areas	miles	2,500-3000	10	NA	25
Trail construction & improvement	miles	5000-8000	1,440	45	360
Road construction & improvement	miles	35,000	1,560	47	315
Roadside observation sites	each	5000	10	5	33
Erosion control:					
Gullies	miles	2500-5000	5	1.5	119.5
Sheet erosion	acres	100-1000	0	5	4,095
Abandoned roads & trails	miles	500-1000	0	0.5	270
Stream bank stabilization	miles	200-2000	0	2	28
Mining control & restoration	acres	100-500	0	5	80
Sediment basin construction	ac.ft.	5000	0	0	5
Recreation:					
New site development					
Camping - picnicking	sites	2,500	0	0	146
Boat launch	sites	15,000	0	0	8
Winter sports[1]	sites	200,000	0	0	7
Wildlife habitat management	acres	15-50	1,500	NA	10,200

[1] Does not include private investment.

In order to more fully appraise the impact of Forest Service programs, an alternative set of assumptions and opportunities has been identified. The alternative is roughly analogous to an Environmental Quality Objective and is very consistent with a broad management direction which emphasizes key values such as dispersed recreation, wildlife, natural beauty, and watershed protection. Development is not an important feature of this alternative, and much of the forest area is reserved formally as Wilderness or by management direction as nondeveloped area.

There is good opportunity to emphasize the key values of this "non-development alternative." As previously mentioned, the basin contains 1,405,190 acres of National Forest land classified as either Wilderness or Primitive Area. In addition, there is about 864,000 acres of roadless area or about 38 percent of the Nonclassified National Forest land, which provides substantial opportunity for dispersed recreation, retention of natural and wild characteristics and similar experiences.

Impacts

Complete implementation of development opportunities would have significant positive impacts on future timber supplies, future minerals production, future recreation opportunity, future livestock production, and future wildlife numbers. Concurrently, some negative impacts would occur, notably in future opportunity for primitive and unconfined recreation and wilderness type experiences. Development could have some adverse impacts on landscape beauty, water quality, air quality, and the opportunity for special interest items such as scientific study.

Selection of the nondevelopment alternative would have significant negative effect on future production, especially of commodities such as timber and forage, and of opportunities for developed recreation such as camping, picnicking, summer homes, downhill skiing, and boating. Restrictions on access would eliminate motor vehicle use from many areas with a possible negative impact on grazing use, wildlife habitat development, wildlife harvest, mineral development, and the opportunity for structural water developments. Concurrently, some positive impacts would occur. These would be primarily related to opportunities for primitive and unconfined recreation, solitude, special interest studies, water quality, air quality, and natural landscape beauty.

Table VIII-4 compares some impacts of Development and Nondevelopment Alternatives. In addition, if the development alternative included installation of erosion control measures to the full extent indicated in table VIII-3, the following reductions in soil losses could be expected:

Measures	Annual soil loss reduction
	tons
Gully stabilization and control	38,700
Sheet erosion control	81,100
Stabilization of abandoned roads and trails	13,500
Streambank stabilization	9,300
Restoration and control of mining areas	30,000
Sediment basin construction	10,900
Forest planting and seeding	30,000

Table VIII-4 --Comparison of some impacts of Accelerated Development and Nondevelopment Alternative, National Forest land, Wind-Bighorn-Clarks Fork River Basin.

Use, service, or product	Unit	Amount Provided	
		Development Alternative	Nondevelopment Alternative
Sawtimber and wood products	thousand board feet	108,000	27,500
Livestock capacity	thousand animal unit months	224.9	162.2
Developed recreation			
camping		2,152.5	1,338.4
picnicking	thousand	302.8	144.8
boating	visitor days	96.25	21.25
winter sports		548.8	344.5
Water yield	ave. annual acre feet	4,333,000	4,323,000
Wildlife harvest			
hunting use	thousand	245	204.2
fishing use	visitor days	1,195.4	1,167
Dispersed recreation use	thousand visitor days	1,492.8	1,079.2
Opportunity for primitive and unconfined recreation, solitude and special interests	qualitative	reduced on about 850,000 acres	No change
Natural landscape beauty	qualitative	reduced on some portions of area depending upon amount of new annual development	No change

State and private forest land development opportunities

There are many opportunities for accelerated development on the state and privately owned forest lands in the basin. There are about 217,000 acres of nonfederal forest land within the project areas of the identified potential small watershed projects which have some opportunity for accelerated forest land development. Existing cooperative forestry programs can be accelerated or initiated. Timber harvesting, timber stand cultural measures, insect and disease control, fire control, and reforestation are all measures which could be used to improve timber production from the basin's state and private forest lands. This increased timber can aid in counter-balancing the reduced timber output of the national forests and contribute to the projected demand for timber. Table VIII-5 lists estimated areas with opportunities for accelerated forest land treatment.

Opportunities for development and management of other public lands

The Bureau of Land Management administers the unreserved public lands which produce wildlife and fish habitat, timber and other wood products, water recreation, minerals, and grazing for livestock. The bureau has an active program of range and watershed improvement including brush control, contour terraces and furrows, fencing, seeding, waterspreading, detention dams, diversions, stockwater ponds, and spring developments. It also has an active program of recreation site selection and withdrawal. The lands are classified for retention in public ownership or disposal to either private individuals or other government agencies. Some of these lands have been turned over to the National Park Service and the Bureau of Sport Fisheries and Wildlife for recreational and wildlife purposes, and other lands have been transferred to the Bureau of Reclamation for the purpose of irrigation or electric power development.

USDA cooperation for resource development on private and federal rangelands in the basin is still in its beginning stages. This cooperation consists of coordinated ranch and allotment plans and working through conservation districts for both private and federal lands. All resources pertaining to the successful operation of a ranch are considered, particularly the crop and rangeland resources. When national forest lands are involved, a comprehensive plan involving these lands is considered.

Recent plan developments and on-the-ground application of these plans have resulted in much improvement of the lands involved. There is still a real opportunity for grazing improvement by improving stockwater supplies. Future operations will continue to conserve and develop the important public land resources.

RURAL RENEWAL OR RURAL DEVELOPMENT OPPORTUNITIES

Agriculture Secretary's Memorandum No. 1667 calls for recognizing that rural development is the primary responsibility of the local people. Within

Table VIII-5--Opportunity for accelerated land treatment and development on state and private forest lands

Item	Amount	
	Wyoming	Montana
	acres	
Timber surveys and plans	196,100	150,000
Timber management:		
Accelerated harvesting	108,100	
Thinning, release, weeding	40,000	44,000
Insect and disease control	500	
Tree planting and seeding	1,200	6,400
Fire prevention and control	58,700	150,000
Public Law 566 watershed assistance	75,000	142,100

Source: Correspondence with Wyoming State Forester and Wind River Indian Reservation Forester; U.S. Forest Service Surveys, Wyoming and Montana; Conservation Needs Inventory; Soil Conservation Service Watershed Investigation Reports; and Beartooth RC&D Report, Montana.

the basin the organization of the conservation districts, the RC&D project, and other local development groups is a fertile field for carrying out the purposes of the rural development program. Each county in the basin has organized rural development county committees to work with the state committee for rural development.

RURAL ELECTRIFICATION PROJECTS

There are several electric cooperatives within the basin. Major responsibilities of these cooperatives is to furnish low cost power for the rural people. At present these cooperatives distribute 380 million KWH to the rural users. There are opportunities to increase this amount.

OPPORTUNITIES FOR WILD, SCENIC, AND RECREATION RIVER AREAS

The Bureau of Outdoor Recreation, under the provision of Section 5(d) of Public Law 90-542, prepared a report on the Yellowstone River. According to the report, most of the Yellowstone River from Gardiner to Pompeys Pillar meets the criteria for scenic or recreational river areas.

A report of the Western U.S. Water Plan on critical water problems

of the 11 western states recommends designation of the Yellowstone River and the Clarks Fork for potential addition to the National Wild and Scenic River System (a Section 5(a) classification).

A bill to establish a state system of wild and scenic rivers was defeated in the 1974 session of the Montana Legislature. Most of the opposition came from farmers and ranchers concerned about access to the rivers for maintenance of existing diversions and construction of new diversions. Because of this opposition to a state system which would have included this reach of the Yellowstone River, Montana is withholding support of a 5(a) classification pending an indication of public support. Over 90 percent of the land bordering the Yellowstone River is privately owned. The local position will be determined through a series of public meetings in the basin.

There is some reason to doubt that the portion of the Yellowstone River bordering this river basin (from Columbus to Bighorn, Montana) possesses "...outstandingly remarkable scenic recreational, geologic, fish and wildlife, historic, cultural, or other similar values." 1/

The nation's need for energy and food will almost certainly require future development of the water of the Yellowstone River in the Billings area and downstream.

The Clarks Fork River originates in southern Montana near Cooke City. It meanders into Wyoming near Pilot and Index Peaks. For the first 20 miles the river flows at a moderate rate through a wide flood plain dotted with ranches and native hay meadows.

At the confluence with Crandall Creek the river drops, literally, into a 20 mile long primitive, scenic, and practically unnegotiable canyon. At the canyon mouth the river flows northward through small ranching communities and finally joins the Yellowstone River near Billings, Montana. Upstream from the canyon mouth the river is mostly in federal ownership--Shoshone National Forest in Wyoming and Gallatin National Forest in Montana. Downstream from the canyon mouth private ownership and public domain lands are intermingled.

The Clarks Fork River is free-flowing; and it traverses an area with unique scenic, recreational, geological, historical, archeological, fish, and wildlife values. The contrasting faces of the river from a placid, pastoral stream in the upper reaches to the awesome white water rapids, waterfalls, and deep pools in the canyon show little of man's influence. The population of the adjacent area is very small. The town of Cody, Wyoming, 36 miles away, is the largest population center. The Clarks Fork Road parallels about 11 miles of the canyon rim but never approaches closer than three-fourths of a mile. From the bridge near the Crandall Creek confluence to the Beartooth Highway the river is adjacent to the Clarks Fork Road. From the junction of the Beartooth Highway and the Clarks Fork Road to Cooke City, Montana, the river shares a broad valley bottom with U.S. Highway 212--the Beartooth Highway.

1/ See Public Law 90-542, paragraph (b).

The Clarks Fork River supports a thrifty fish population and provides high quality stream fishing. Most of the tributaries to the river are very productive also. Sunlight, Crandall, and Dead Indian Creeks are rated as very good trout waters with the fisheries of state-wide importance. The Clarks Fork itself is rated as important trout water with the fisheries of regional importance. Black bear, grizzly bear, mule deer, elk, mountain goat, various predators, waterfowl, upland gamebirds, eagles, falcons, and other game and nongame animals are abundant in the canyon and upper river valley.

The area's historical significance stems chiefly from the journey of the Nez Perce Indians under Chief Joseph. The entire band, including women and children, successfully eluded the U.S. Army by traveling down Dead Indian Creek, negotiating the face and sheer cliffs of the Clarks Fork Canyon. They emerged at the mouth of the canyon and escaped into central Montana.

There are several proposals for development which could affect the river. The Bureau of Land Management and Bureau of Reclamation have a power withdrawal along the length of the canyon portion. Two dam sites for hydroelectric power production have been proposed. One is in sec. 26, T. 56 N., R. 104 W., and the other is in sec. 10, T. 56 N., R. 105 W. Determination of which use--power production or wild and scenic river designation--has priority for this reach of the river will have to be made. A proposed all-weather highway is located in the canyon, but the location has been disapproved by State officials. The issue is quieted, but not dead, as future pressure may be mounted to construct the highway in the canyon if the river is not included in the National Wild and Scenic River System.

The Wind River above Boysen Reservoir has been identified by the Department of Agriculture for possible inclusion in the national system. However, existing reclamation and irrigation projects significantly affect the flow of water in this section of the river. The Wind-Bighorn River from Boysen Dam to the mouth of Wind River Canyon flows through an area which has particularly unique geologic and scenic values which may also make this reach eligible as a recreational river.

No proposal for USDA action in these reports would significantly adversely affect the designation of any part of the Yellowstone, Clarks Fork, or Wind River as a part of the National Wild and Scenic River System.

Other streams in the basin might also be studied for designation as a part of the system as follows:

Lake Fork Rock Creek above national forest boundary
West Fork Rock Creek above national forest boundary
East Rosebud Creek above Alpine
West Rosebud Creek above Mystic Lake
Forks of Stillwater River above national forest boundary
Wood River above its reservoir diversions
Greybull River above Pitchfork
North Fork Popo Agie above national forest boundary

Middle Popo Agie above national forest boundary
Medicine Lodge Creek above Hyattville
Paintrock Creek above Hyattville
Little Bighorn River above State Line
South Fork Shoshone River above Valley
North Fork Shoshone River above Buffalo Bill Reservoir
Tensleep Creek above Tensleep

Few of the streams listed above are well suited to recreational use for floating. The use of the Shoshone, Bighorn, and Yellowstone Rivers for this purpose might be enhanced more through a formal legislated declaration that the water surface, bed, and banks of these rivers below the normal annual high water line constitute navigable and public streams than by including them in the National Wild and Scenic River System.

Several locations for dam sites have been identified on the streams listed above. The value of these sites must be evaluated before these streams are designated as part of the national system.

IX. INTERAGENCY COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

The present and future needs of the people in the basin can best be met through the development and improved conservation of the basin's resources. Many of the needs of the people are identified and explained in Chapter III. The basic needs for improved resource conservation and development are explained in Chapter V. Estimates of the physical potential for the development of water and related land resources are found in Chapter VII. Agencies of the U.S. Department of Agriculture have several existing programs for managing the resources of national forest lands or assisting in the conservation and development of resources managed by private owners and local governments. Several specific opportunities for the development, conservation, or preservation of resources through existing and accelerated USDA programs are identified in Chapter VIII.

However, there are project and program opportunities and needs for resources development beyond the scope of existing USDA programs. Some of these opportunities can be developed without USDA action, but most can be enhanced if existing or enlarged USDA programs are included in interagency efforts. Changes in some of the existing programs, agency responsibilities, or new programs may be required to best meet some of the needs of the people for the resources of the basin. This chapter suggests some alternative approaches, describes some proposed developments and programs of other agencies, discusses the potential of using basin resources outside the basin, and discusses the need for expanded USDA programs.

ALTERNATIVE APPROACHES TO WATER AND RELATED LAND RESOURCE DEVELOPMENT

There are numerous approaches to the management or development of water and related land resources. For the purpose of this report the basic approaches are:

Private development
Local government programs
State government programs
Other federal agency programs
Each of the above with USDA assistance
USDA action

Each of these basic approaches will have variations based on economics, regulations, program or project options, conservation needs, and interagency relationships.

Private development

Private action in resource development will continue in response to opportunities to improve living standards and produce profits. This report contains useful information for individuals and businesses. General information about projected future demands, resource capabilities, resource problems, and resource limitations will be useful in making investment decisions. More specific information and technical assistance can be provided at local offices of USDA agencies.

Local government programs

Much that is said above can be stated for local government action. Public services also become a major consideration. The information in this report about projections of population, employment, recreation, and potential projects should be very useful to city and county governments.

State agency programs

The Water Resources Division of the Department of Natural Resources and Conservation in Montana and the Governor's Interdepartmental Water Conference and its represented agencies in Wyoming have responsibilities to coordinate various federal, state, and local water development projects. In the near future, federal financial assistance for construction in water and related land resource development for agricultural purposes may decrease. During the same time, federal technical assistance for planning will probably continue at about the present level while federal regulations for water quality and flow control will probably increase. Therefore, if early development is desired, other alternative approaches should be considered. The best near term opportunities appear to be suited to state projects and state assisted private developments.

There may also be a future bonus for increased state involvement. As national priorities change, more federal assistance may become available. Any actual increase in federal assistance will probably be based on a matching increase in state and private activity. Those states best organized for resource development will likely benefit most if federal assistance is increased.

Several RC&D project measures proposed in both states will need state assistance for completion. Both states are encouraged to expand their programs of technical and financial assistance programs in resource development.

Some of the USDA proposals for PL-566 watershed project type action face certain hurdles as federally assisted projects because of present laws and policies. Nevertheless, they offer excellent opportunity for development in a timeframe consistent with regional needs. Specific examples include: Midvale Watershed, where the primary opportunity is the irrigation of new land presently reserved by the Bureau of Reclamation; Cyclone Bar Watershed, where the project will irrigate pastureland not presently irrigated; and Gooseberry Creek, where there is an opportunity for inter-watershed transfer of water.

In addition to the watershed project type opportunities mentioned above, the two states have identified other potential projects for state action. For example, the Wyoming Water Planning Program in Wyoming has proposed three alternative projects involving a large reservoir on Clarks Fork. The proposals are to irrigate land in the Clarks Fork Basin or to supplement this development with irrigation of the Polecat Bench area and provide water for municipal and industrial uses.[1/]

1/ Water and Related Land Resources of the Bighorn River Basin, Wyoming, Wyoming Water Planning Program Report No. 11, October 1972.

Cooney Dam is an existing state project in Montana. The dam needs repair, but may have additional potential which should be considered before extensive repair work is done. Other existing water resource projects could also be repaired or improved through state action.

Other federal agency programs

Bureau of Land Management

The Bureau of Land Management administers more than one-fourth of the land in the basin. Action programs of the Bureau include:

a. Improved range management to bring 50 percent of the public range area to "good" range condition. Also, the area now rated as "poor" and "bad" is to be improved to "fair" condition. Forage under these improved conditions could increase by 208,000 animal unit months.

b. Range and forest fire and insect control.

c. Resource development through contour furrowing, seeding, and sagebrush control to reduce erosion while improving the range.

d. Forest management to improve timber yield.

e. Development of new camping and other recreational facilities and upgrading roads for access to public lands.

f. Minerals inventory and development.

g. Road construction.

h. Lands classification.

i. Cadastral surveying.

Any program for the public land which affects grazing use will affect agriculture in the basin. A reduction in forage taken from the public lands would require either a reduction in animal units in the basin or an increase in forage produced on private land. An increase in forage taken from the public land might reduce grazing pressure on private rangeland but would probably encourage an increase of animal units in the basin. This would also require increased forage production on private land, especially for winter feed.

Conversely, changes in the management and use of private forage-producing land can result in both positive and negative impacts on the public range. The timing as well as the amount of grazing is critical to the management of all rangeland. Therefore, any changes in grazing policies for the public land need to be keyed to programs to improve the management of all forage-producing land. USDA agencies can and should be actively involved in the development and coordination of such programs.

Bureau of Reclamation

The Bureau of Reclamation has been developing water storage, irrigation, and electric power projects since the beginning of the century. Existing reclamation projects in the basin were described briefly earlier in this report. There are no less than a dozen different proposals for new reclamation projects in the basin. Most are not large, and several involve extensions or enlargements of existing project facilities. In the near future, there may be more interest in developing hydroelectric power and industrial water than in irrigating new lands with federal projects. However, forage production in the basin could be increased through the development of new reclamation projects.

Corps of Engineers

Manderson, Wyoming, is periodically flooded from both Nowood Creek and the Bighorn River. The Corps has proposed a levee to provide protection from ice jams and floods. The project is feasible and may be developed when local residents are able to pay for the local share of the costs.

Bureau of Indian Affairs

The Bureau of Indian Affairs assists the Indian tribes in the basin with development of plans for new irrigation, improved agriculture, new industries, new recreational facilities, improved education programs, and numerous other projects under the trust responsibility of the federal government to Indian lands and tribes.

One of the most pressing legal questions involved in resource development in the basin concerns the water rights of the Indian tribes. A statement of the Bureau of Indian Affairs on this question is:

> In protection of Indian rights under the trust responsibilities, the Interior Department is now in the process of inventorying land and water uses for both present and future needs for all purposes. Confirmation will be accomplished by legislative, administrative, or court action.

The opportunity for USDA program assistance on Indian reservations will be severely restricted until this legal question is answered.

NEED FOR INTERAGENCY COORDINATION

Water, air, and land provide the life support system of the earth and are vital to every enterprise of man. The natural resources are interrelated so completely that every development of a resource affects other resources in some way. Because of this, it is impossible to create an agency for one kind of development or management which will not relate to the actions and duties of another agency. It is so with the agencies mentioned in this report. Therefore, interagency coordination is essential for orderly development of natural resources. Perhaps the most urgent need for interagency

coordination is in the development and exchange of technical information. There are also opportunities for joint action programs and projects.

USDA agencies can and do provide technical information about the use of natural resources to almost anyone who asks for it. One restriction does exist. Information that is confidential to an individual landowner or business may not be publicly disclosed without permission from that landowner or business. If the desired information is presently available, there is generally no charge for it. If new surveys are required, beyond the scope of existing programs and funds to obtain them, there may be a charge to help pay for the survey. State, private, and local government agencies should coordinate their planning efforts with USDA agency information and programs.

USDA agencies can provide a great deal of information about water and related land resources and the conservation use of these resources. Much of the general information available about the basin is included in this report. More detailed information is presently or can be made available about:

Soils
Irrigation management
Crop management
Range management
Forest management
Forest products
Wildlife needs
Pollution control in agriculture
Watershed hydrology
Farm and ranch economics
Watershed projects
Foundation geology
Ground water availability
Private and forest recreational potential
Drainage design
Annual streamflow forecasts
Conservation planning
Small project design
Other conservation needs

There should be continued and closer coordination between USDA agencies and the Bureau of Reclamation in reclamation project development and management. Soils information in project areas should be developed at the beginning of planning in a way which will not only provide the design information needed but serve the needs of the settlers for conservation planning. Reclamation projects can be more successful with an active assistance program in conservation farm planning of the kind provided by USDA agencies.

USDA and Bureau of Reclamation programs are often quite compatible and should be coordinated. The rehabilitation of existing irrigation systems and installation of drainage in reclamation project areas can be accomplished through programs of both agencies. Education and technical assistance for

improved irrigation water management is available for both programs. The RC&D committees could be very useful in providing leadership in coordinating activities by the two federal programs.

The Bureau of Reclamation, state agencies, and USDA agencies are interested in the management of precipitation or other weather modification. Individual agencies should not be allowed to pursue weather modification projects without interagency coordination.

Indian tribes have representatives on the RC&D committees. Activities on the reservations should be coordinated with other activities in the basin. Tribal councils should investigate the possibility of using more USDA programs and technical assistance to improve resource management practices on Indian lands.

Recently, a number of environmental agencies outside USDA have attained new prominence with legislated direction to regulate pollution, enhance fish and wildlife habitat, improve recreational facilities, and otherwise improve our natural environment. USDA agencies are working more closely with these agencies since policies require the preparation and review of environmental impact statements. The preparation and review of these statements can be a much easier process if agencies involved coordinate their efforts early in the planning stage. Other agencies should not overlook any opportunity to cooperate with USDA agencies. Each state has a clearinghouse agency which helps to coordinate state and federal planning and project efforts.

NEW USDA PROGRAMS OR CRITERIA TO MEET NEEDS

It is estimated that only 46 percent of the nonfederal lands will be adequately treated by the year 2000 if present programs are continued at the present level of technical assistance and financing. If we expect to meet additional conservation needs and the changing environmental and recreational demands, both new and accelerated programs will be required.

While detailed soil surveys are generally complete on presently irrigated land, they are usually not available for other land in the basin. Many projects and programs need basic soils data for proper planning and design. The need will become more pressing as environmental problems increase. The proper management and restoration of mined areas requires detailed knowledge of local soil characteristics. Proper management and treatment of rangelands, croplands, or timberlands must be based on such knowledge. The soil survey program for the basin should be accelerated.

Accelerated USDA programs are also needed for state and private forest lands. The existing cooperative fire management programs should be reinforced and extended to areas not now included. Timber production, watershed protection, and land use planning needs could be met by accelerating the cooperative forest management cooperative tree distribution, cooperative watershed, general forestry assistance, and tree planting and reforestation programs. Accelerated use of the advisory management program

to assist the State Foresters in managerial improvement, work measurment, work planning, and organization and management of programs would have beneficial effects on all forestry programs.

Acceleration of existing watershed management programs on the national forests would reduce erosion and sedimentation and help stabilize water runoff. Production of needed goods and services from national forest lands could be enhanced by acceleration of ongoing programs affecting resources such as recreation, wilderness, wildlife, livestock, and timber.

The Resource Conservation and Development Program has been conceived to expand the opportunities for conservation districts, local units of government, and individuals to improve their communities in multicounty areas. The Bighorn Basin RC&D Project has listed 82 project measures needed and possible in the Wyoming portion of the basin. Preliminary cost estimates for 52 of these projects amount to more than $80,000,000 just to construct. Under existing guidelines more than 50 percent of this cost is eligible for federal assistance. A major portion of this assistance qualifies under programs administered by USDA agencies. To date, however, this program has been limited by lack of funds and adequate personnel for proper administration. RC&D funds must be accelerated if these projects are to be completed in reasonable time.

POTENTIAL USE OF WATER RESOURCES OUTSIDE THIS RIVER BASIN

The physical potential exists to transfer large amounts of water from this basin to other basins to the east. Projected needs for the Powder River Basin, in particular, far exceed its existing water supplies. There is potential conflict between existing and future needs within the basin and those outside the basin. The Bureau of Reclamation has performed a reconnaissance survey and given options for up to 640,000 acre-feet of water in the Wind-Bighorn River to be transported to points in eastern Montana and Wyoming for industrial purposes. One hundred and ten thousand acre-feet are to be used on the Crow Indian Reservation. One hundred and eighteen thousand acre-feet will be used in other areas in Montana, and the remainder are to be used in eastern Wyoming.

The 640,000 acre-feet is an estimate of the flow remaining after assumptions were made concerning depletions for proposed developments on the Wind River Indian Reservation, completion of the Hardin Bench Unit, Little Bighorn and Dunmore Units, the Riverton Project, and for projects of other agencies. Minimum flows for maintaining hydroplant capabilities and environmental requirements were also considered.

At present, the Yellowstone River Compact prohibits transfer. This compact may be renegotiated. The states involved will need to assign priorities and balance the use of water between the river basins.

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 11 500      Prepared under the direction of USDA Field Advisory Committee.
 12 651  3   Wind River (Wyo.)
 13 651  3   Bighorn River (Wyo. and Mont.)
 14 651  3   Clarks Fork River (Mont. and Wyo.)
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 16 650  3   Water resources development ǂz Wyoming.
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 20 710 20   United States. ǂb USDA Field Advisory Committee.
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